# THE ENGINEER.

## GIO. ANSALDO e CO

By E. CAPEL CURE.

### Gio. Ansaldo e Co.

CHAPTER I.—HISTORICAL NOTES.

It is not only in England that the year 1846 is memorable in connection with railway construction. In that country a glistening bubble was shimmering its brightest before bursting, and the eve of "King" Hudson's reign was darkening as the gathering clouds of the "panic year" loomed denser. But, in spite of all, a tangible result was to be shown for the misery that was soon to crush so many families. That result was the possession by the United Kingdom of over three thousand miles of railways. Italy, on the other hand, had made but two small efforts, two toy lines as it were, the five-mile stretch from Portici to Naples and the dolls'-house railway ordered by the Pope to connect his city with Frascati. Yet from 1846 we must date an epoch in the history of Italy, for it was in that year that her railway system was conceived. The *Nouvelle Revue* of Paris came out with a remarkable article, in which it sketched the future project of Italian locomotion with an exactness which would have been little short of astounding if the writing and the scheme itself had not been due to the prophetic brain of that calm master moulder of events and men, Camillo di Cavour.

To meet the demand for railway plant which this article foreshadowed was born the firm with which we have to deal. It now employs in its four works between Genoa and Sestri more than 10,000 hands; the number in 1846 was nearer 100 than 10,000 in the little workshop at Sampierdarena. The firm had just been established by Taylor and Prandi, but it changed hands in less than seven years and passed to Giovanni Ansaldo, the man chosen by the great Turinese statesman as an instrument for his vast scheme of making industrial and economic independence in Italy march parallel with her political resurrection. Essential to this latter end was the instant completion of the Piedmontese railways, which a few years later were to help to win Palestro and Magenta by enabling the French allies to concentrate at Alessandria. To the new owner of the Sampierdarena workshop was entrusted the construction of the first two locomotives in 1854. "If we never begin to patronise home industries," said Cavour to the Sardinian Council of Admirals, "it is certain that our home industries can never develop." That development was, however, retarded by the commercial treaties consequent on the necessity of keeping friends with France. Work in the locomotive trade was therefore scarce, and Ansaldo turned his attention to the making of artillery and projectiles and to the building of iron ships, a new branch in which England then held an undisputed monopoly. In this departure he was again encouraged by Cavour, and materially aided by a man whose name constitutes another landmark in the history of the firm. That man was Carlo Bombrini, member of the Senate and director of what is now the Bank of Italy. The venture was no slight one. The Elban mines were then in the hands of strangers, who exported all the ore which returned in the form of pig iron; coal also came entirely from abroad. But, in spite of these difficulties, the first years proved a success, till 1858 saw the death of Giovanni Ansaldo. Though denied the satisfaction, granted to Alessandro Rossi, of seeing his work accomplished, he is yet to be reckoned among the great industrial pioneers of his country. He bequeathed to his successors not only his name, but also a tradition which they have held ever since as a priceless heritage, the tradition of bold initiative and of sagacious commercial foresight.

The next quarter of a century was spent in developing the new enterprise, and the firm became year by year more precious as a national institution whose unfolding coincided with and abetted the unfolding and consolidation of modern Italy. The difficulties to be faced from a financial standpoint increased, however, instead of diminishing. Blast furnaces there were none, and material paid high duty and expensive freights. No profit was in reality to be gained from building iron ships, while, to make matters worse, iron was beginning to give way to steel, for the working of which no shops existed in the country. Then in the face of these obstacles came the death of Cavour, the industrial crisis, and the even more slip-shod management of the works, which Senatore Bombrini, engrossed as he was by his great life's work in the National Bank, found himself powerless to control. At his death in 1882 the firm was in serious difficulties.

It was saved from liquidation by the foresight of his two sons, Comm. Carlo Marcello and Senatore Giovanni Bombrini, who, while inheriting the large fortune of their father, gratuitously assumed responsibilities from which they might have escaped. The management was taken over by them, the technical directors were changed, and among the new appointments was that of Ing. Antonio Omati, now Commendatore Omati, the present Director-General, who assumed the reins of the shipbuilding department. The firm was still a small one, and though known both to Government and the trade for the excellence of its products, it employed only about 800 hands. It possessed about 150 machine tools, and its shops covered about 400,000 square feet. The annual value of its output up to 1882 had never surpassed £60,000. In that year it rose to £140,000. In short, chaos had given place to order, and lethargy to activity.

"Italian Industries for Italy." Such was the motto of the brothers Bombrini. Regardless of risk and expense, animated by an unswerving faith in the future of Italian industry, they launched into a series of improvements and amplifications. A nucleus of English engineers was taken on, some of whom—as Mr. de Grave Sells, Mr. T. H. Baird, and Mr. C. H. Gilbert—afterwards engineer-in-chief to the Chilian navy—stayed with them for many years. The rights of making the Maudslay boiler were secured, the works at Sampierdarena were enlarged, the shipyard transferred to Sestri Ponente, the Delta foundry bought up at Cornigliano, the fitting-out shop acquired in Genoa Harbour. Fortune favoured the brave. Steel works were founded at Pra and Savona, and began to multiply; international competition became possible. In 1887 Senatore Finali declared that, if Senatore Bombrini had left the national bank the most powerful financial institution in Italy, his sons had performed the almost greater feat of raising the firm of Gio. Ansaldo e Co. from the state of a tottering concern into the category of houses of the first degree.

It was during these years that Ferdinando Maria Perrone, father of the brothers Perrone of to-day, first came upon the scene. Born in Alessandria on January 8th, 1847, he showed from his youth the combative energy which, united to indomitable activity and daring spirit of initiation, combine to form a character more common in the Anglo-Saxon than in the Latin race. Endowed with an ample fortune, he proved deaf to the blandishments of luxury and chose from the first "To scorn delights and live laborious days." His fighting instincts impelled him to the post of danger and self-sacrifice, in spite of his infinite capacity for suffering, which fretted the body to decay. He died, as it were, in the climax of the battle, and missed by one sole instant the object since attained by his sons, and to which he had given his life.

Volunteer with Garibaldi when only eighteen he gained the highest distinction of an Italian soldier, the silver medal for valour, at Condino. He had hardly returned when the civil medal for bravery was also conferred on him as organiser of the corps which assisted the sufferers in the cholera-scourged town of Torre Pellice. At the age of twenty-three, in 1870, we find him fighting for France, for which country he had a feeling of affection second only to his love for Italy. This was his passion, that his land should be respected abroad, that his countrymen should never disgrace the name they bore. "Do you want me, an Italian, to seem afraid of pain before Austrians?" he indignantly asked of a friend who had begged him to have chloroform for an operation in Vienna the year before his death. Such was his

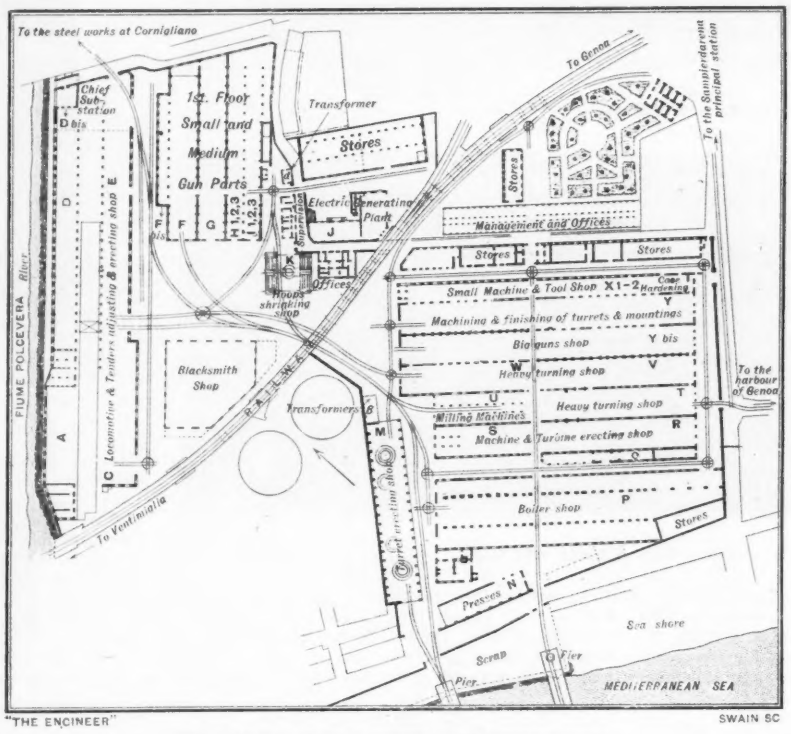



Fig. 1—PLAN OF THE WORKS AT SAMPIERDARENA

# EXAMPLES OF MILD STEEL MILLING CUTTERS

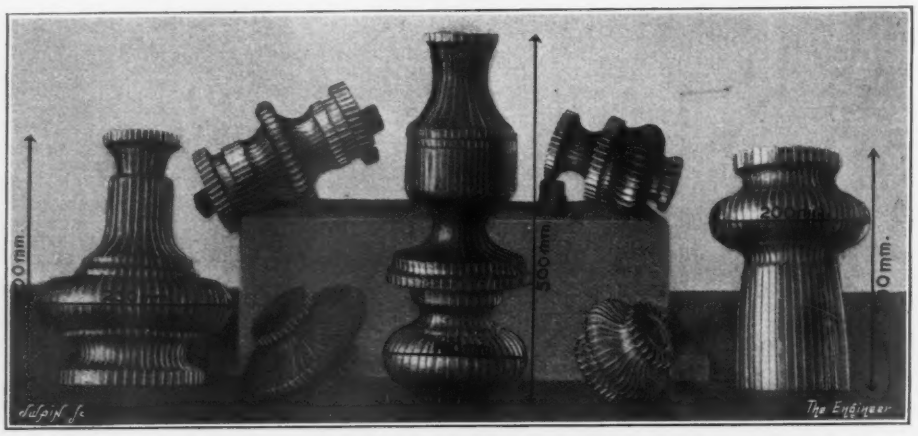



Fig. 2—MILD STEEL MILLING CUTTERS

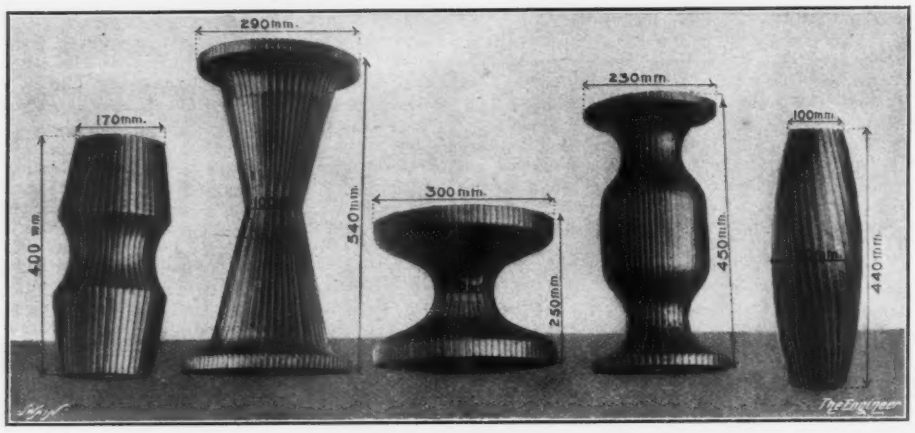



Fig. 3—MILD STEEL MILLING CUTTERS

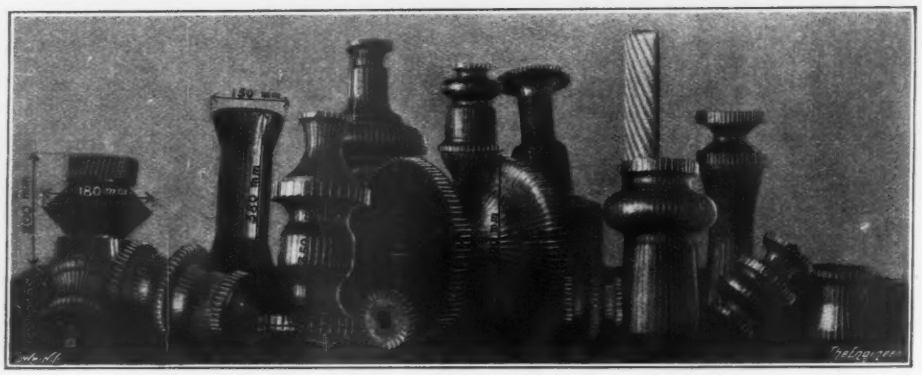


Fig. 4—MILD STEEL MILLING CUTTERS

sterner side ; his diplomatic powers and quick resource were equally remarkable. In his first audience with Abdul-Hamed, the Sultan complained of a claim for £12,000 which Italy had been urging for five years as compensation to her subjects during the Armenian massacres. He could not recognise it, he added, for fear of losing his prestige with the people. Perrone was silent, but after a few days requested another audience, and, entering, presented the Sultan with the Italian Embassy's receipt for the amount. "Your Majesty," he said, "will no doubt permit me to add the sum, which I have paid myself, to the cost of one of the battleships. The debt need not be admitted, and the poor people will receive their money." If Perrone had lived, the war in Africa might, perhaps, have been averted. His death cut short the negotiations he was engaged in for the cession of the harbours of Tripoli and Bengasi. His success at Ansaldo's was originally due to his popularity in Argentina, for which country he had raised a corps when menaced with war by Chili. Orders for battleships were the result, and other orders followed fast from Turkey, Spain, and Japan. Millions flowed into Genoa ; a new era had dawned on Italian naval industry.

These events happened about 1895, and at the same time a bitter war broke out against the author of them, a war which hastened his death, but is a proof of the value set upon him by his enemies. Italy, though obtaining orders for ships of a pre-established type, was unable to enter the lists of international competition, for the gun and armour plate works were in the hands of strangers. Perrone, who had by this time become head of the firm, thought to break down the barrier by an alliance with Armstrong's, to whom 40,000 shares in his company were assigned. But the discrepancy between the objects in view of the two parties was too profound to allow of the arrangement being a workable one, and the attempt to reconcile them wore down the already over-wrought frame of Commendatore Perrone, who died in Genoa on June 9th, 1908.

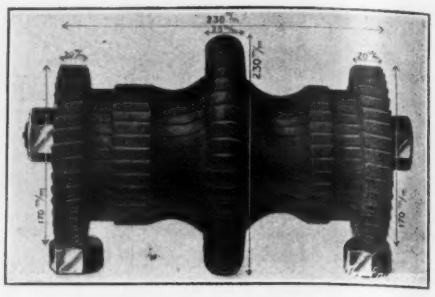



Fig. 5—COMPLETE CUTTER (See Fig. 7)

But his work lived after him. He had just succeeded in regaining possession of the large share held by others in his works, and was thus able to leave them, free of all outside influence, to his sons Comm. Pio and Mario Perrone. To them has been reserved the satisfaction of realising their father's dream. Endowed with his most salient characteristics, they have risked an immense capital to build and furnish in less than three years huge works for guns and armour plate. These enable them to construct and equip in their own shops and by purely Italian labour a Dreadnought from keel to truck. These workshops are considered by specialists of the highest standing as being among the finest in the world, if not, indeed, actually *the* finest. They undoubtedly contain the finest plant that has ever been put together. In addition to these great new buildings, the various establishments previously existing have been radically altered, and whole departments have been created afresh. There has been no patching up. New wine has been put into new bottles. The result is a co-ordinate and harmonious whole, giving the greatest rapidity of production and the maximum output in the minimum space of time. The visitor is in doubt

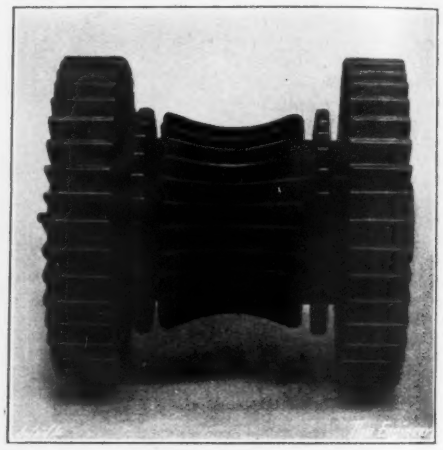


Fig. 6—COMPLETE CUTTER (See Fig. 8)

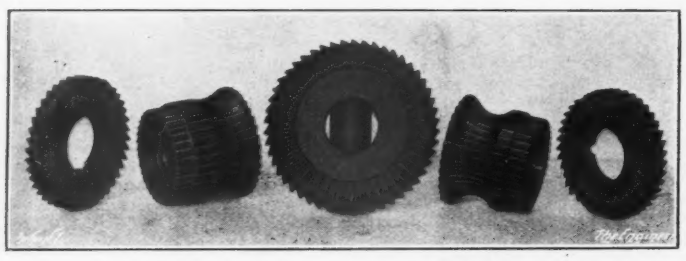


Fig. 7—PARTS OF THE CUTTER ILLUSTRATED BY Fig. 5

Fig. 8—PARTS OF THE CUTTER ILLUSTRATED BY Fig. 6

whether to be more astonished at the magnitude of the original enterprise or at the perfection of its present organisation. Italy has gained a unit of first power in her independence and national strength. The new factor is one to be observed. It will make itself felt ere long in the Mediterranean and beyond the pillars of Hercules.

## CHAPTER II.—SAMPIERDARENA.

(1) *Cutters, Case-hardening and Callipers.*—Twenty minutes in the tramway brings the visitor from Genoa to the suburb of Sampierdarena. Here are the headquarters of Ansaldo's firm, covering an area of 904,170 square feet (84,000 square metres).

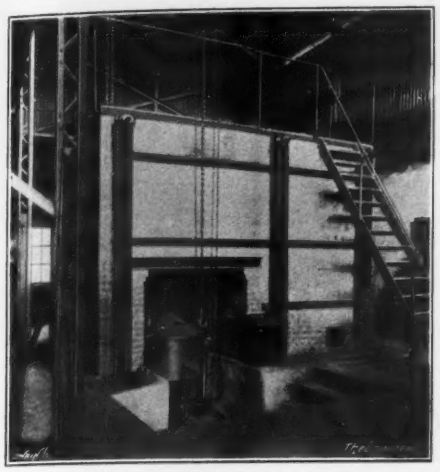


Fig. 9—CASE-HARDENING FURNACE

Sampierdarena is rightly called the heart of the great industry. To that point the mass of rough material flows from the Delta and steel works at Cornigliano; from it, it passes out again to give life to the shipyard at Sestri Ponente, or to the fitting-out establishment at the Molo Giano.

Entering by the principal gate in Via Giovanni Ansaldo, near the manager's offices—see Fig. 1—the shops immediately before us are those where the great guns are made. This department will be treated in detail later on. We will therefore pass on to the section marked X 1–2, a two-storey building, containing the tool-making shop, 230ft. by 33ft. (70 m. by 10 m.), and including the section where tools are forged, and that where the case-hardening of them and of small parts is carried out.

Milling is carried out to quite an extraordinary extent in this department, and the process and the results are alike remarkable. Nearly all the tools, some of which reach quite large sizes in one piece, whilst others are built up, are made from ordinary mild steel and case-hardened under the "Ansaldo" patent of Professore Federico Giolitti. In Figs. 2 to 8 opposite we give a number of examples which will show how varied are the shapes and sizes. The process adds about ½d. per pound to the low cost of the material, and the outlay on these cemented cutters, as compared with the sum that would have been expended if tool steel had been used, is therefore easy to gauge. The mild steel, which has a resistance of about 64,000 lb. to the square inch (45 kilos. per square millimetre) is forged to the approximate shape of the cutter desired, leaving a 10 per cent. to a 12 per cent. margin for finishing. It is then turned, bored and toothed, the teeth being usually made with a normal cutting angle of 60 deg., except in rare cases where an angle of 55 deg. is given for exceptionally quick cutting. Finally, after having been fettled by hand, it is passed on for hardening.

An ordinary horizontal muffle furnace can perform this operation, but at Ansaldo's it is effected in a special vertical muffle furnace by Ch. Stein, of Paris, —see Fig. 9—which has the advantage of facilitating the charging and withdrawal of the charcoal and pieces of steel. This can be done with an electric crane to obviate the necessity of the workmen having to approach the furnace. There are two types of the latter. The first is made with two or three cylindrical muffles of about 19in. diameter, and is a suction-gas furnace with coke gas producer built into the body. It is used when working continuously or on a large scale with from 600 lb. to 2 tons of pieces, and is said to have an output about four times that of an ordinary furnace with hardening boxes. The pieces to be case-hardened are lowered into the chamber, and a stratum of granular carbon is poured on to them. Then more pieces follow, and more carbon, till the chamber is full. After carbonisation, the pieces are extracted from above and the carbon discharged from below. The cost of case-hardening—with upkeep and capital cost reckoned—is given as less than ½d. per pound (6.8 centimes per kilogramme).

When working intermittently, or on a less extensive scale, a smaller furnace heated with ordinary gas or with heavy mineral oils is used. Its daily output is not over 600 lb., but it can stop working at any moment, and has the further advantage that its production can be reduced to a minimum of 40 lb. per day without raising the cost to more than ½d. per pound, including all expenses. The temperature is kept at between 900 deg. and 1050 deg. Cent., and is controlled by a thermo-electric pyrometer. The agent used is carbon monoxide, CO, obtained by passing a current of carbon dioxide, $CO_2$, through a mass of incandescent granular wood charcoal. The depth of the case-hardening, in a given time. can be regulated by the pressure of the gas The concentration of the carbon can be pre-determined by diluting the carbon mc noxide with nitrogen, by limiting the contact of the granular carbon with the steel, or by varying the temperature. Uniform and pre-ordained results can therefore be obtained. Super-carburated zones and consequent local fragility are avoided, "peeling" is done away with, and even the least accessible angles of a complicated piece come equally under the influence of the vapour, since the action of the agent is like that of a liquid, and therefore possesses a pervading power unattainable with solid carburising materials. Should the pieces be properly annealed so as to eliminate internal tensions, deformation becomes a negligible quantity. No rectification is, in fact, found to be necessary in the case of locomotive pistons of 37½in. (950 mm.). Another advantage will be seen on looking at the micrographs — Figs. 10 and 11. There is no clearly defined line between the carburised and non-carburised zones of the metal.

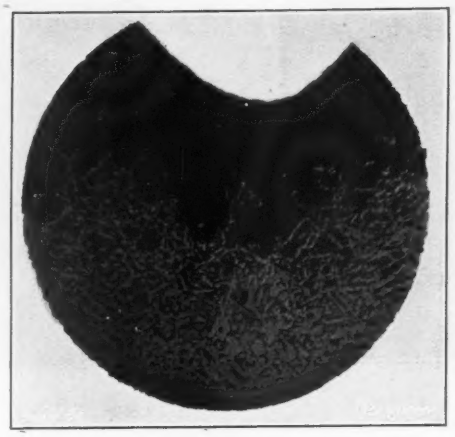


Fig. 10—MICROGRAPH OF CASE-HARDENED STEEL

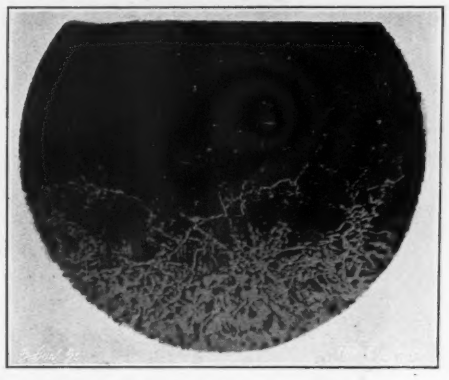


Fig. 11—MICROGRAPH OF CASE-HARDENED STEEL

The low cost, which has already been mentioned, is due partly to the small consumption of case-hardening boxes, which are no longer subject to constant re-heatings and re-coolings, the pieces and the granular carbon being charged hot at a temperature of from 800 deg. to 900 deg. Cent. The fuel bill is, besides, much less, and no highly skilled labour is necessary to place the pieces in the boxes and surround them carefully with composition. The carburising material can be used almost indefinitely, since only that portion is consumed which exercises a direct action on the steel. The consumption is, in fact, we are told, about one-hundredth of what it is with other processes. Besides these economies, there is a great saving of time. The charging of 550 lb. (250 kilos.) of pieces into the hardening chamber, the loading of the carburising material and the starting of the cementation should not take more than eight minutes. The depth of carburisation in a given time is claimed to be greater than with any other agent yet tried, solid or gaseous. For hardening to the depth of ⅛in. to $\frac{5}{32}$in. (3 mm. to 4 mm.), the depth normally practised for milling cutters, an average of about fifteen hours is required at a temperature of 900 deg. Cent. The concentration of the carbon can be regulated between .6 per cent. and 2 per cent., and great gradations of hardness are therefore obtainable.

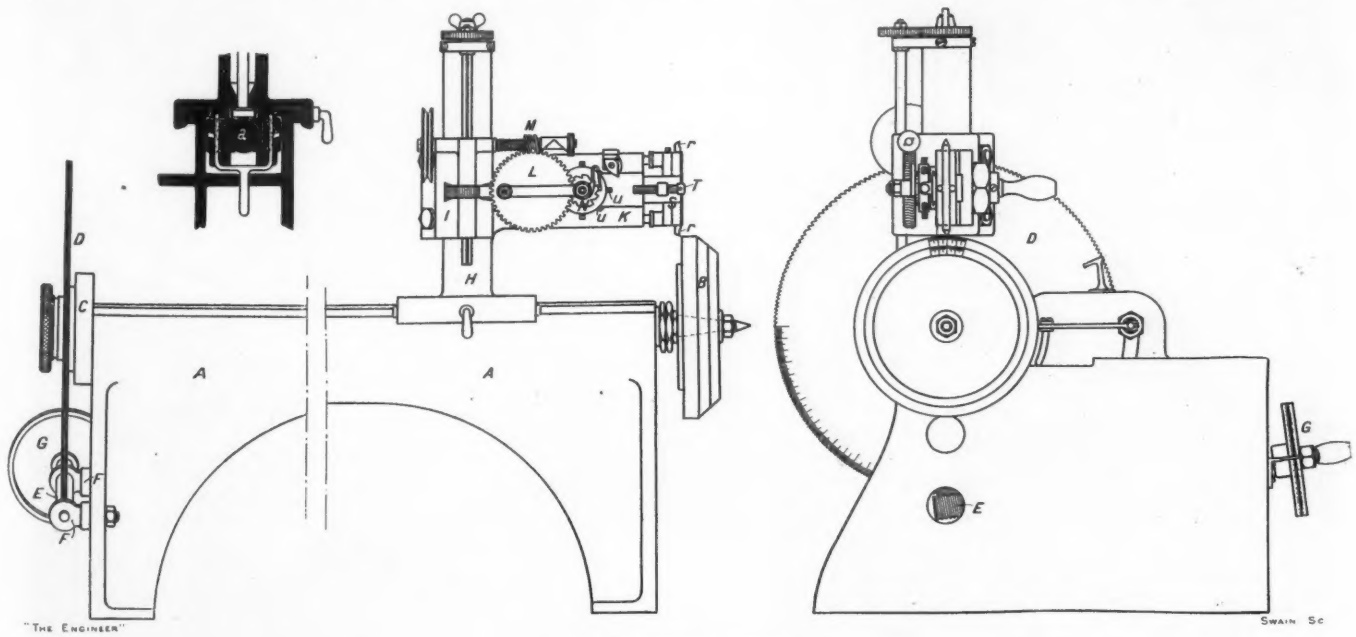



Fig. 12—DIVIDING ENGINE

Returning from the general to the particular, the milling cutter, which has now left the hardening furnace with a hardened skin about 3 mm. thick, is cooled in hot ashes as slowly as possible, and is then reheated in the salt bath by a Ferguson refuse oil furnace, and plunged in water. It now returns to the tool shop for correction on automatic emery grinders

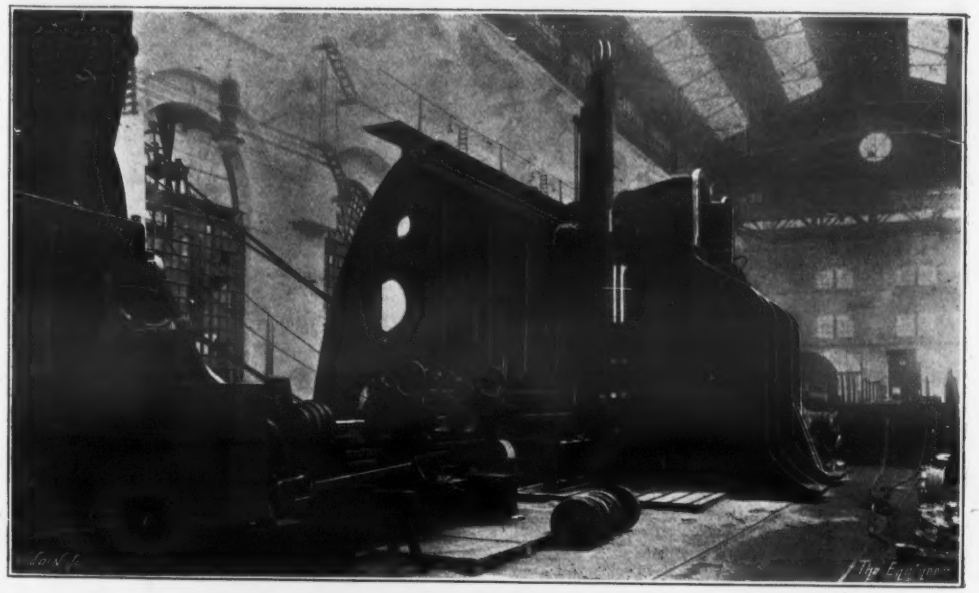


Fig. 13—VERTICAL PLANING MACHINE

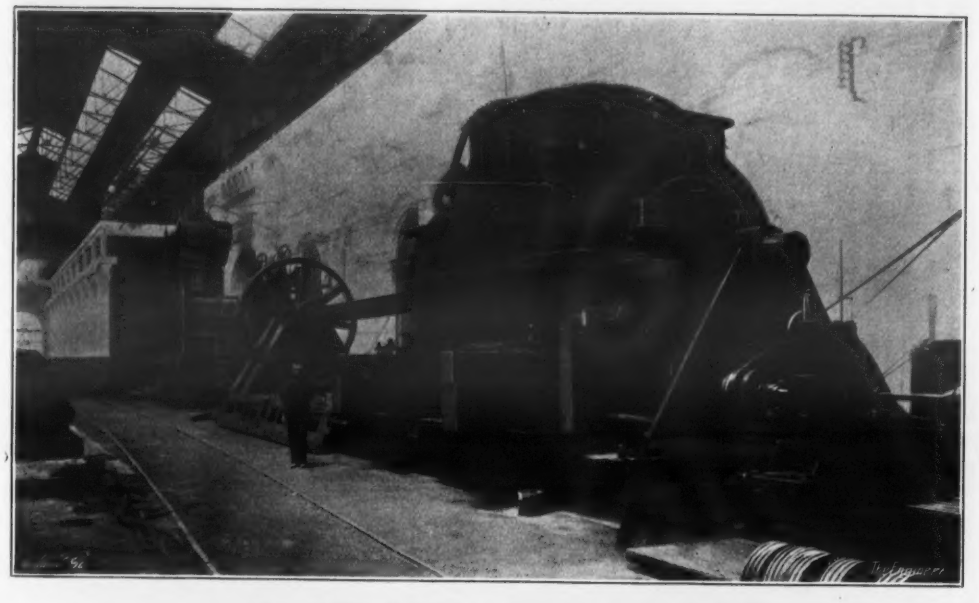


Fig. 14—BORING MACHINE AT WORK ON TURBINE CYLINDER

Fig. 15—TURBINE ERECTING SHOP

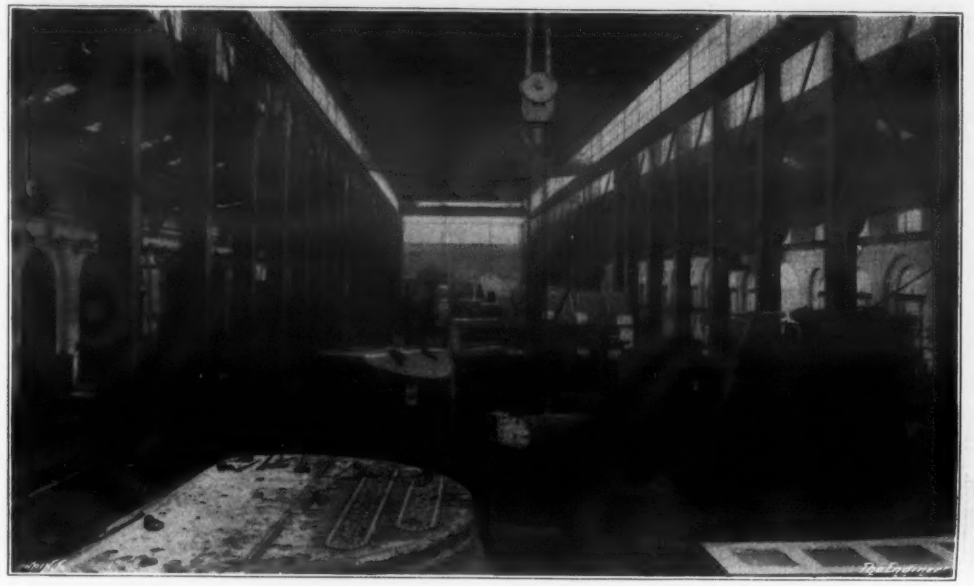


Fig. 16—BOILER SHOP

and for the necessary "backing off," after which it is ready for use.

The practical results shown by daily experience are certainly most satisfactory from the point of view of durability. A cutter has, as a rule, a life of from 350 to 400 hours continuous working, without re-hardening, and bears four or five re-sharpenings, which reduce the diameter each time by about two-tenths of a millimetre. Given the facility with which mild steel can be worked, the most intricate profiles are possible, as will be seen by the engravings already referred to. The dimensions, besides, of these tools are no mean ones, when it is considered that they can be made up to 23⅝in. (600 mm.) in length and 31½in. (800 mm.) in diameter.

The tool shops naturally furnish every other sort of appliance of which the works have need in the various qualities of steel.

The last section of the department is entrusted with the making of the callipers, gauges and measuring tools, and is provided with a plant of the utmost precision for the manufacture and checking of such things. Among these, Ansaldo's patented dividing engine—Fig. 12—for marking rules, &c., to the 128th of an inch, or the quarter of a millimetre, is specially noteworthy. The drawings may be better understood by the following brief notes:—A A bed of the machine on which the rule to be graduated is placed. B, cone dial, to be graduated on all its faces, fastened at the end of a screw *a* of the same length as the bed, and having a pitch of 1 mm. A case *c* is fixed at the other extremity, and contains a spiral spring, together with a disc graduated on both faces and cogged round its circumference, which latter is connected with a worm *e* carried by two supports F F and rotated by the wheel G, also graduated. H is a pillar sliding on the bed, which can engage with the above-mentioned screw *a* when a rule has to be graduated—see detail section. I, sleeve sliding on the pillar to regulate depth of cut. L, worm wheel which receives its motion from a worm M driven by a small pulley, and through a connecting-rod causes the reciprocation of the turret head N. S, tool holder, to which screw *r* is attached. This screw receives the motion from the screws *u* made of various lengths so as to obtain the different lengths of lines on the rule being marked. *r*, two tools. K, arm which can be inclined at any angle about centre of L.

For unequal graduation or for the minutest dividing, as into tenths of a millimetre, the disc D is used and is moved by hand. For uniform and broad graduations, as, for instance, those of 1 mm., another disc is substituted, having its circumference spaced to a millimetre. In this case it is moved automatically. The instrument has been working for more than a year, and has given complete satisfaction.

(2) *Heavy Lathe Shops, Engines, and Turbines.*—Passing out of the tool section and again leaving aside the gun works, the next department reached is that of the heavy lathe shops V W and T U, each 49ft. broad (15 m.) by 460ft. (140 m.) and 426.5ft. (130 m.) long respectively. It is clear at once from the size of the tools here that they are intended for the heaviest work. It is here, in fact, that the great iron and steel castings and huge forgings that are sent from the Cornigliano foundry and steel works are turned, bored, and planed. The castings for the turbines of the first six Italian Dreadnoughts issued from this shop, as well as those for the cruisers and scouts. There are over 350 hands here, of which the greater number have been educated by the firm—a fact which constitutes a moral patrimony for Ansaldo's, and adds to the interest of the men in their work. The engines of the new 32-knot scouts are at present being made here. The turning of the great drums was done on two electric lathes of 5ft. 10⅞in. (1.8 m.) and 8ft. 2$\frac{7}{16}$in. (2.5 m.) centres, whilst two vertical planing machines—see Fig. 13—of 120 tons weight each machined the cylinder flanges. The latter are driven by 40 horse-power motors, and have a working surface of 21ft. 4in. (6.50 m.) vertical and 24ft. 7¼in. (7.50 m.) horizontal. The cylinders are bored on two machines taking pieces up to 49ft. 2½in. (15 m.) long by 19ft. 7½in. (6 m.). These huge tools—see Fig. 14—have almost all been constructed by the firm, which builds for itself when time permits. Another remarkable lathe in this shop has 5ft. 3in. (1.6 m.) centres and a length of 65ft. 7$\frac{7}{16}$in. (20 m.) between centres. There are also two large tools for drilling and screw-cutting, while a peculiar gear-cutting machine deals with the helical gear of large wheels for turbine motors. This machine cuts wheels up to nearly 10ft. (3 m.) diameter, and is furnished with a novel arrangement for correcting the well-known periodical errors due to irregularity of the feed.

Large shafts and parts for marine steam engines, of which the firm has made so many for the Italian navy and other clients, are constructed in a different section of the same shop. Another department handles the heavy pieces for locomotives, and its multiple-cylinder boring machines are of home production.

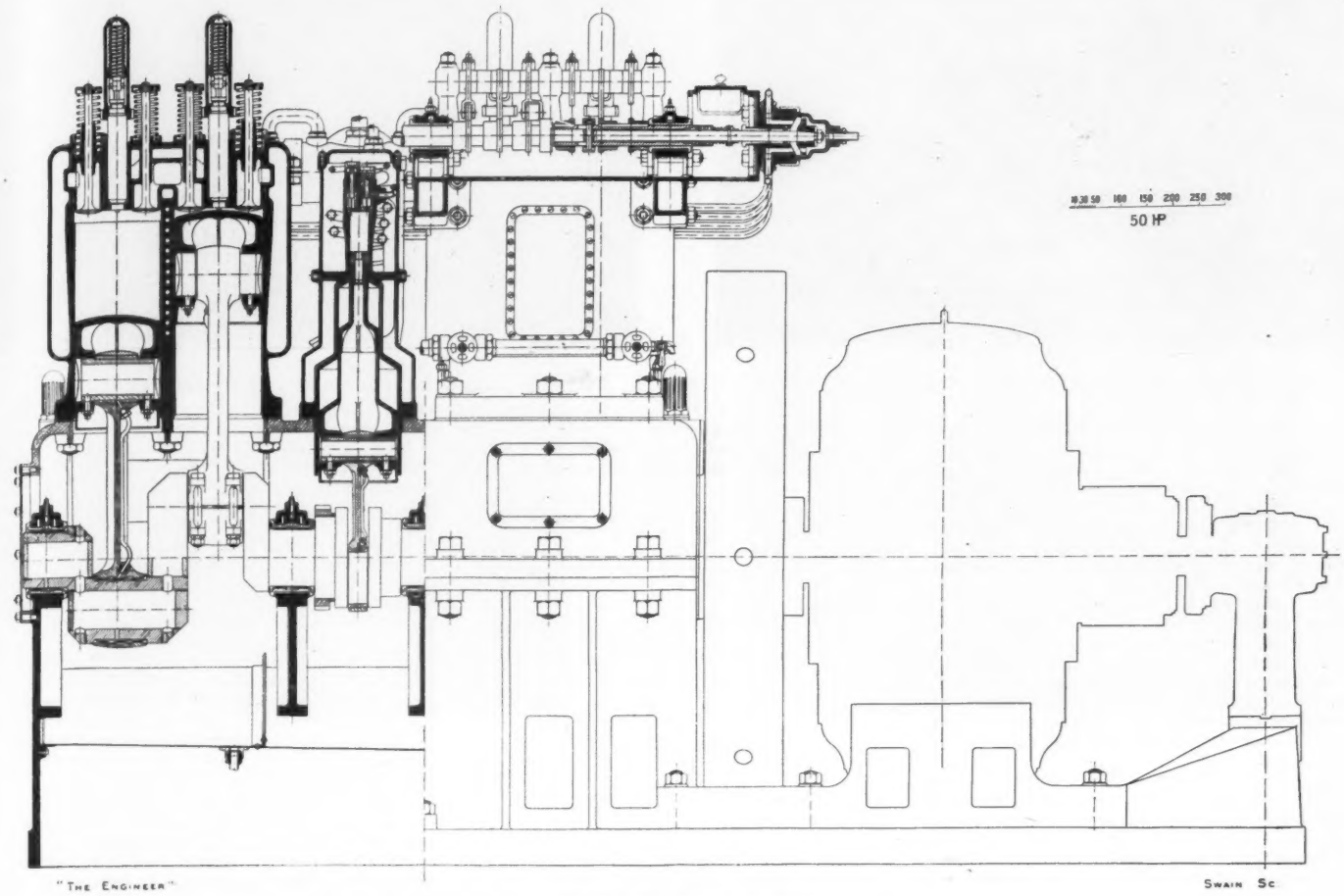



Fig. 17—50-H.P. DIESEL ENGINE

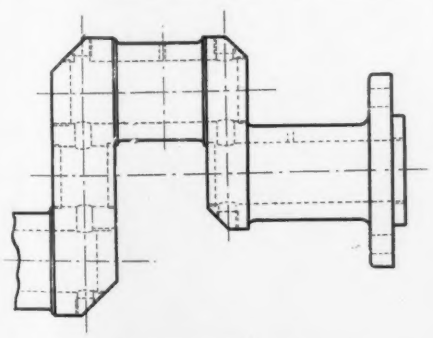


Fig. 18—CONSTRUCTION OF SHAFT

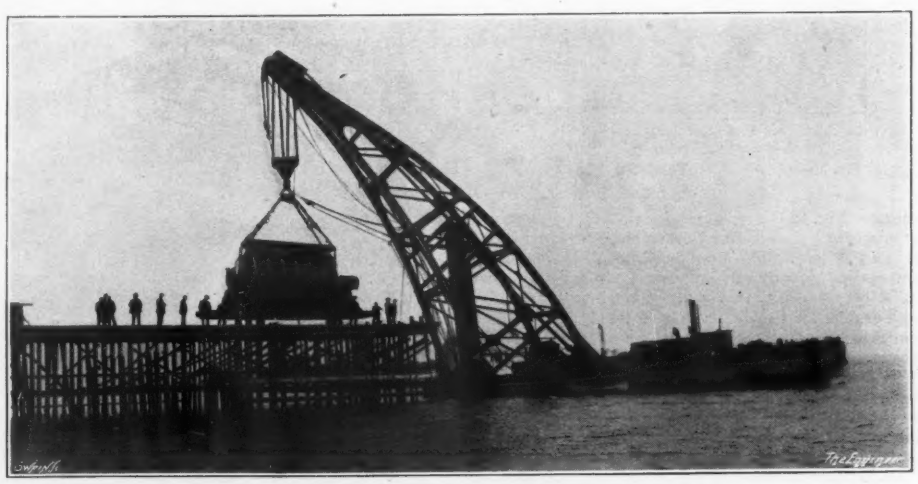


Fig. 19—JETTY AND FLOATING CRANE

The section for the making of internal combustion engines has a total of 156 machine tools, and is served by overhead electric travelling cranes of from 50 tons lifting power downwards. This department was lacking at Ansaldo's not many months ago, and the success which has immediately crowned the firm's initiative is shown by the work now in hand, including some large four-cylinder 2000 horse-power engines for a central electric station, several units for the Italian navy, and a considerable number of engines for searchlights in coast stations. Special care has been given to the composition of the iron for the cylinders, and the best formula has been found to be C 3.81 per cent., Si 1.36 per cent., Mn 0.87 per cent., P 0.30 per cent., S 0.028 per cent. This composition has a resistance of 25,602 lb. per square inch (18 kilos. per square milimetre); and a bar $1\frac{9}{16}$in. (40 mm.) square between supports placed $6\frac{5}{16}$in. (160 mm.) apart, shows a resistance to impact of 17.6 lb. (8 kilos.). Drawings of a 50 horse-power Diesel engine for an electric set for scouts are shown in Fig. 17. The shaft is forged all in one piece, and for the sake of lightness, the journals and pins are bored through, the ends of the holes being filled with screwed plugs—see Fig. 18.

At the end of the bay (U 1–2) a battery of milling machines is at work, and the cutters before described are used on a large scale on hard steel as well as on mild. Taking one of the normal types, it may be noticed that the cut is $\frac{1}{32}$in. (15 mm.), and the feed $\frac{3}{64}$in. (1 mm.).

The erecting and trial shed (R S) for engines and turbines—Fig. 15—is parallel with the last two sections. Reciprocating steam and Diesel engines are equally represented here. The shop employs about 550 workmen, and is served by four electric overhead cranes, two of 60 tons and two of 30 tons lifting capacity. These cranes load the parts on to trolleys, which run them down to the jetty (O) by the sea—see Fig. 19. A network of piping containing compressed air at about 100 lb. abs. per square inch (7 atm.) is to be noticed in this building, and is fed by a compressor of about 706 cubic feet (20 cubic metres) capacity. In the smaller shed (Q), adjoining, the turbine blades are finished, and the segments built up by special plant all made by the firm. It may not be out of place therefore to pause for a moment to describe the process.

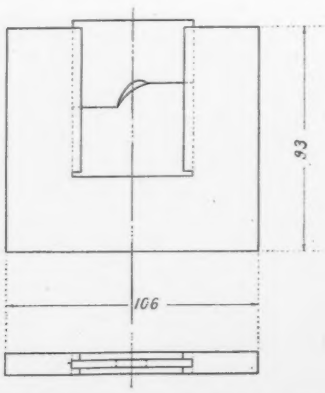



Fig. 22—GAUGE FOR TURBINE BLADES

The manufacture of turbines—see Figs. 20 and 21—by the Parsons patent was undertaken by Ansaldo's almost from the beginning. Comm. Perrone had, in fact, been one of the first to appreciate its value, and immediately acquired the exclusive rights for Italy with the object of amplifying his radius of production and of using the concession as an offset against the disadvantage, under which he was then labouring, of dependence on others for the making of armour plate and guns. The first large order he received was in 1906 for the 20,000 horse-power turbines of the San Marco, and last year, is engaged on those of the 35-knot scouts under construction at Sestri Ponente, and is beginning to build the turbines for the super-Dreadnoughts in this year's programme.

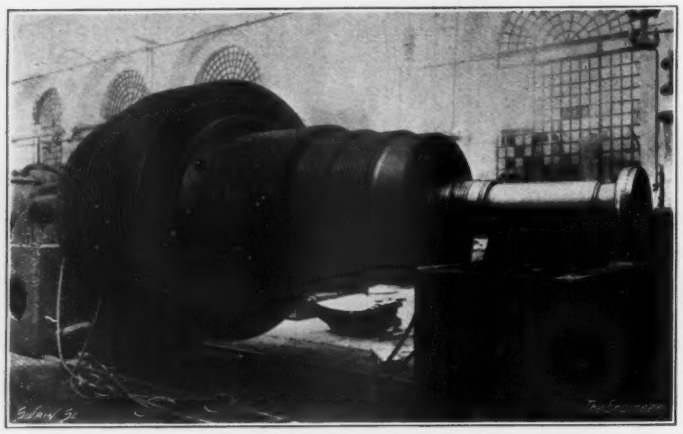


Fig. 20—ROTOR OF CENTRAL TURBINE OF THE DANTE ALIGHIERI

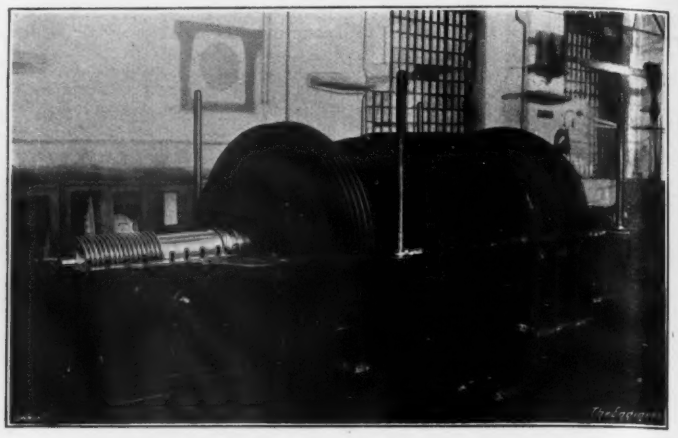


Fig. 21—TURBINE FOR THE SCOUT ARDENTE

islands, those for the four first Italian Dreadnoughts, and for all the scouts. These vessels have without exception exceeded their contracted speed, the Giulio Cesare showing about a knot more than was expected, and two of the scouts steaming at over 34 knots. The turbine department, having now finished the engines of the two new Dreadnoughts of

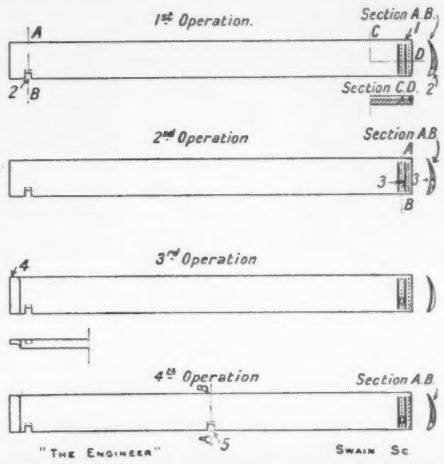



Fig. 23—MACHINING OPERATIONS ON TURBINE BLADES

The turbine blades, whether impulse or otherwise, are drawn by the "Dick" process in the Delta works at Cornigliano—see a later section entitled the Delta Works—and are sent in lengths to Sampierdarena, where they are worked up in the department now before us. Their exact dimensions are first checked by means of special steel gauges—see Fig. 22—of which standards are kept for every type. There are as yet fifteen of these types at Ansaldo's for blades and twenty-four for packing pieces. The machining then begins, and is effected by semi-automatic machines, which separately perform the four operations shown in Fig. 23. The final process (5 A B), applied only when treating long blades, is the production of the central notch for the reinforcement. The blade is now straightened with a wooden mallet, and is ready for mounting in segments, an operation performed in cast iron clamps curved to the radius of the drum for which the blades are destined. There is a row of 40 of these clamps in the shop. The blades and packing pieces are then tightly pressed together with the caulking tool, and the lashings are soldered on with silver alloy. For this purpose borax flux is kept in a liquid state and painted over the parts of the segment to be soldered. All swelling of the borax during the soldering is thereby avoided. The segments are then passed into the depôt and listed.

No visitor to the works can fail to be struck with the perfect organisation of this department, and also with the amount of "finish" put into the turbines. From first to last the work is to be classified in the highest category.

The accompanying drawings, which will be seen to portray the very latest types, show some of Ansaldo's turbine arrangements for warships to be built for foreign Governments, for it should be said at once that the Italian Admiralty, following the British, has closed its doors to all publicity, even of the most circumspect character. All drawings for the Italian navy are therefore kept strictly private. Fig. 29 is the drawing of the turbines of a 1000-ton 35-knot scout of 24,000 horse-power, with two turbines acting independently, and each one driving its own propeller shaft direct. The fore part of the turbine is for

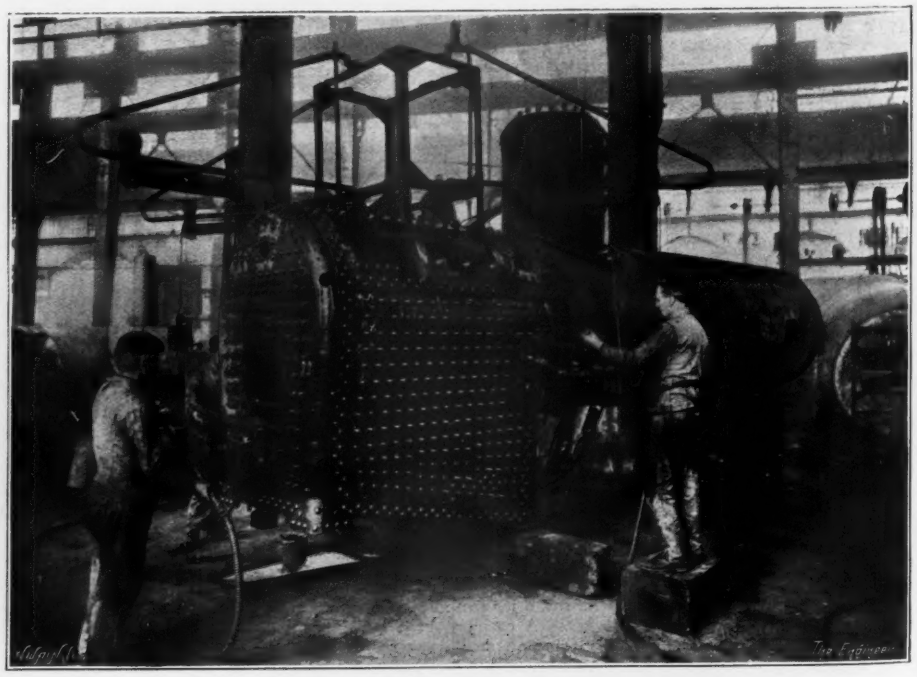


Fig. 24—PNEUMATIC TOOL CARRIERS ON LOCOMOTIVE BOILER

Fig. 25—THORNYCROFT BOILERS FOR TORPEDO BOATS

Fig. 26—BELLEVILLE BOILERS FOR ARGENTINE CRUISER

Fig. 27—YARROW BOILERS FOR DREADNOUGHTS ANDREA DORIA AND DUILIO

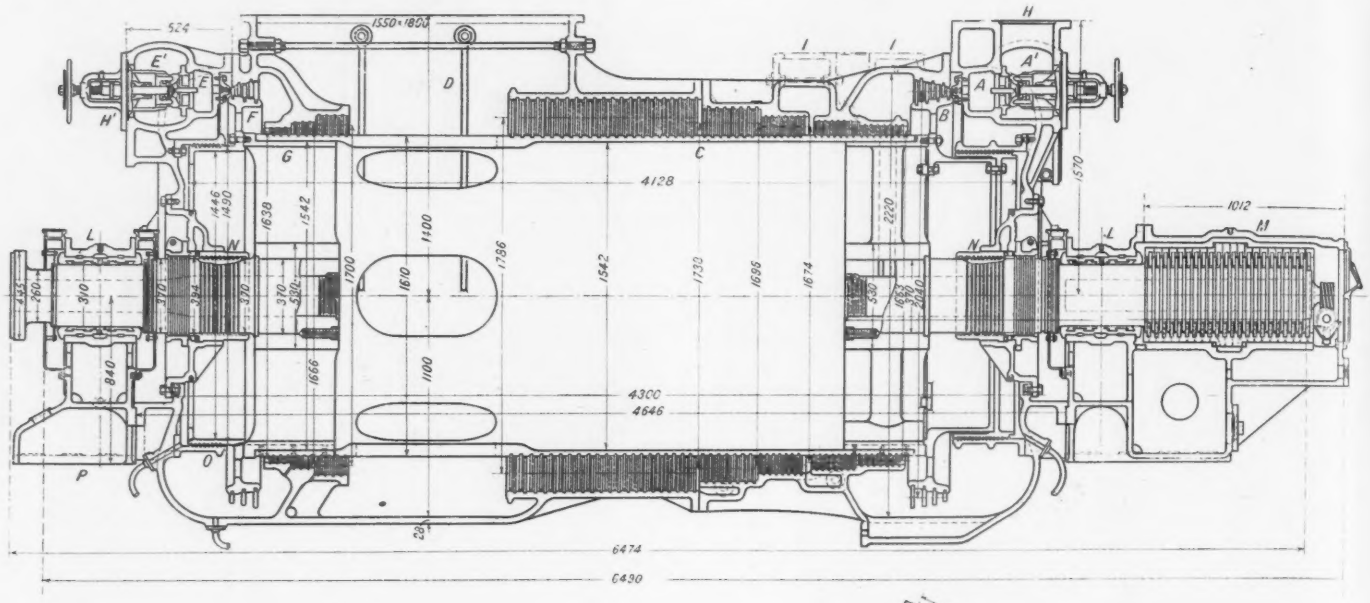
Fig. 28—SCOTCH MARINE BOILERS

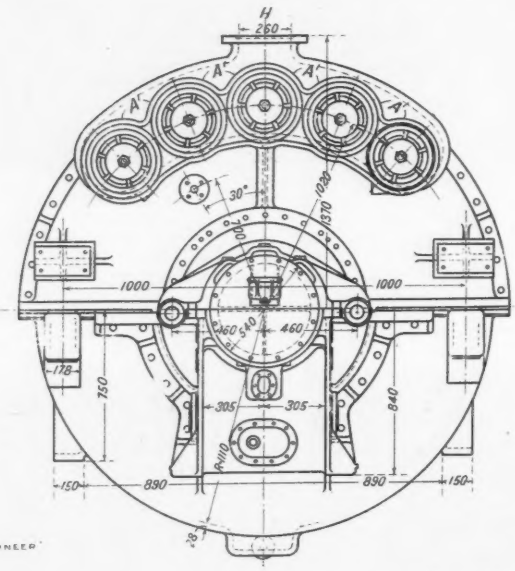
going ahead and the aft for astern. The admission of steam is effected at the two extremities, and the exhaust takes place as usual between the ahead and astern drums. Both drums have reaction blading. The nozzles on the impulse side are distributed in groups, each of which is fitted with a stop valve for the regulation of speed. The turbine goes astern at about 55 per cent. of its power when going

great care in manufacture, and increases the difficulty of maintenance. The advantages and disadvantages may be said to counterbalance each other. The difference between the two designs depends merely on the preference expressed by the Governments acquiring the ships.

(3) *Boilermaking Department.*—Parallel to the shops last described is the boiler works (P). The shop—see

and includes a Fielding and Platt 1000-ton hydraulic press, and another by the same house with two inclined cylinders for bending Yarrow bottom drums. The plates are heated in two crude oil furnaces which can be lit and brought to 800 deg. Cent. in forty minutes. Among the many other tools of note are six radial drills by Asquith, and bending rolls, which take plates up to 14ft. 7in. (4.50 m.). There is besides



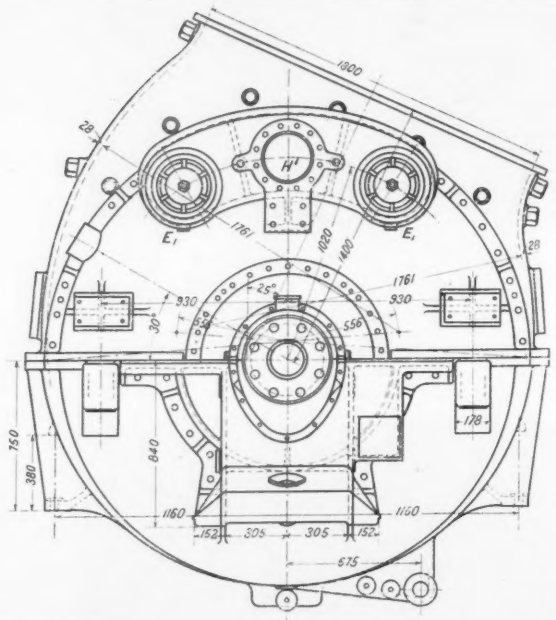




**Fig. 29—TURBINE FOR A 24,000-H.P. SCOUT**

A Ahead Nozzles.
A1 Steam Admission Valve.
B Impulse Wheel—ahead.
C Reaction Wheel—ahead.
D Exhaust.
E Astern Nozzles.
E1 Steam Valves.
F Impulse Wheel—astern.
G Reaction Wheel—astern.
H Main Steam Admission from Boilers—ahead.
H1 Main Steam Admission from Boilers—astern.
I Admission of Exhaust from Auxiliary Machinery.
L Bearings.
M Thrust Blocks.
N Labyrinth Packing.

ahead. In one of our Supplements is shown the engine and boiler-room arrangement of a battleship of 48,000 horse-power, with 28 Babcock and Wilcox boilers, having 532 elements and superheater similar to others already built by Ansaldo's. The low-pressure and astern turbines are here direct-coupled, whilst the others are geared. The turbines drive four shafts and are in six compartments, whereas the boilers are distributed in 12 sections. The arrangement of both boilers and turbines, as also that of the piping and auxiliary machinery, is effected with the object of division into four groups, one for each propeller shaft, and completely independent one of another. In another Supplement is shown the engine arrangement of an ultra-modern battleship capable of developing 60,000 horse-power. As in the former case, impulse and reaction turbines are employed. Cruiser elements are added, and can be thrown out of gear when steaming at full speed. Each of the turbines drives one of the four screws, the wing turbines being of 12,000 horse-power and the central turbines of 18,000 horse-power. Twenty four Yarrow-type boilers, some fired with coal and some with liquid fuel, provide steam, but the coal-fired boilers are so made that they can burn liquid fuel if necessary. The boilers and machinery are arranged, as in the last case, in four isolated groups, and the difference consists in the type of boiler and also in the use of turbines all direct-coupled to the shaft instead of being partly gear-coupled, as before. The advantage of the gear turbine is a gain in weight for the same power, since the turbines can run at a higher number of revolutions, but, on the other hand, the gearing adds another organ to the whole, requires

Fig. 16—measures 460ft. by 115ft. (140 m. by 35m.), and employs about 450 hands. Here, again, the same clear-headed organisation is displayed. Each type of boiler has its separate locality, and each class of operation its allotted space. The boilers turned out are of every sort, size, and shape known—see page vii.—and the names, past and present, on the order-book speak for themselves. A large number of the Italian ships,

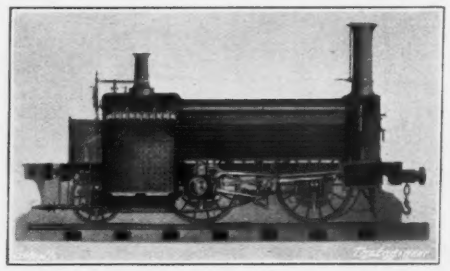


**Fig. 30—THE SAMPIERDARENA**

both for the navy and the mercantile marine, together with such others as the Nissim, Kasuga, and Cristobal Colon, have had their boilers from this shop. The Andrea Doria and Duilio—see Fig. 27, page vii.—are also among the customers, while at the present moment the shops are engaged on twelve 9000 horse-power boilers for Italian and Chinese scouts. The plant is modern, as, indeed, everything is at Ansaldo's, a vertical riveter for barrels of 150 tons and a number of double shears built by Ansaldo. There are two cranes of 40 tons burden, a hydraulic three-cylinder 1000-ton press, and compressed air and oxy-acetylene plants both fixed and portable. There is, besides, an interesting machine made by the firm for the water test of tubes, in which the pressure of the water ensures automatically a water-tight joint between the tube under examination and the flange. Lastly, before leaving this department to which the exigencies of space forbid us to dedicate a more detailed description, a word should be said of the ingenious adaptation of brackets made here for holding up hand riveters, tapping machines, and other pneumatic tools. Fig. 24 shows three of these arms in use on a locomotive boiler. The advantages are obvious. Greater precision is attained than with the lever method, holes are not ovalised, less time is employed, and the workman is not tired. Since adopting this method it has been found that only two or three tubes per 1000 have to be discarded for leakage instead of 5 per cent., as was the case before.

Going down to the wharf (O), we pass the shed (N), in which the small hydraulic presses of 250 tons, and less for boiler and artillery work of ordinary dimensions are housed. Here, too, are the hydraulic presses for banding projectiles. From this point we should turn back to the blacksmiths' shop (L) which occupies an area of 26,910 square feet (2500 square metres), and is well worth a visit, as being everything that technical experience combined with modern hygiene can produce. The lighting is perfect both by day and night, and there is an entire absence of smoke, which is drawn away through underground

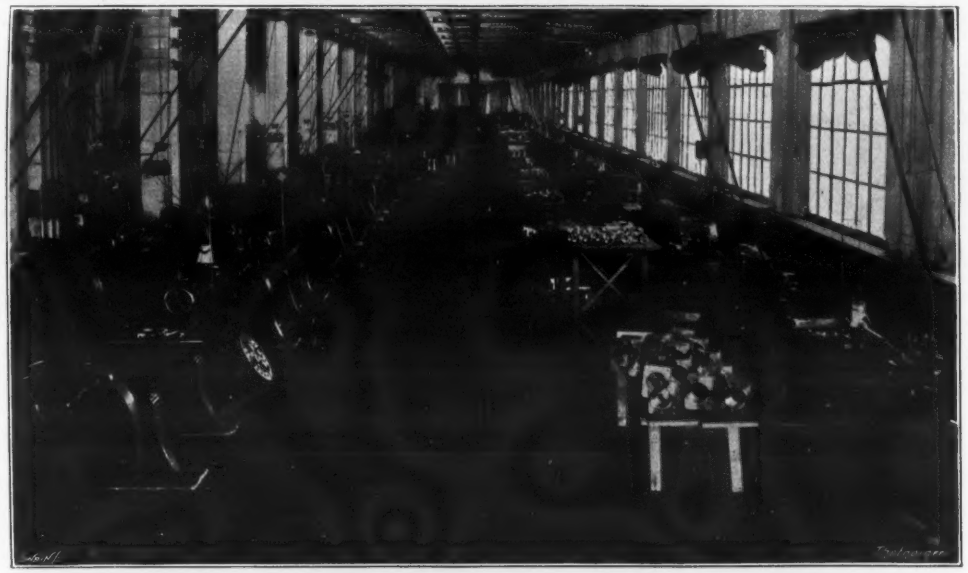


Fig. 31 - SMALL TURNERY, SOUTH END

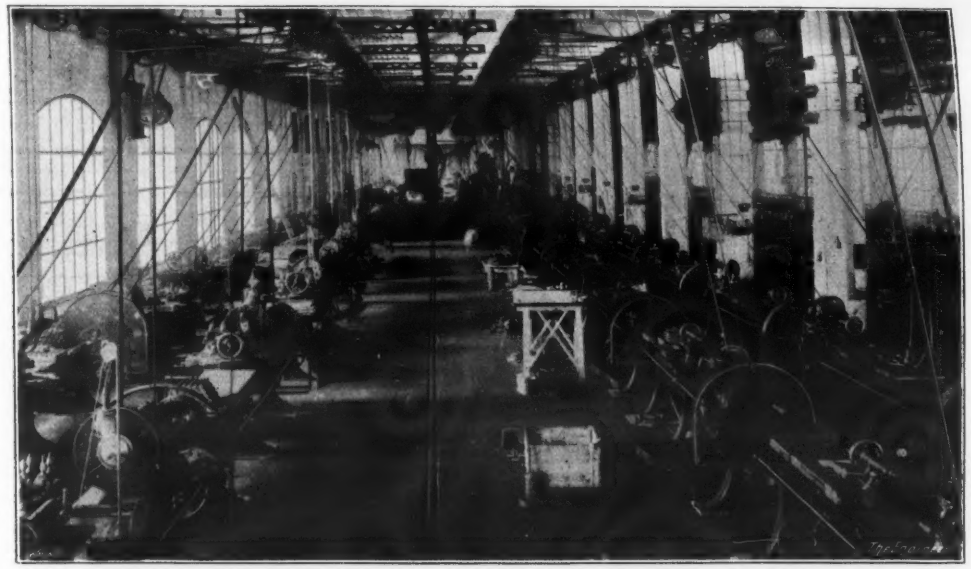


Fig. 32—SMALL TURNERY, NORTHERN END

Fig. 33—LOCOMOTIVE ERECTING SHOP

Fig. 34—LOCOMOTIVE SHED

tunnels by electric fans. It has been found that the individual output has increased since the men moved to this new shop. The cranes here take weights of 4 and 7 tons, and the forging is done by 4, 3, 2, and 1-ton steam hammers made by Ansaldo, Allen and Massey. The total number of furnaces is 45, with 70 hearths, and the hands number about 200.

Opposite this shop is the new turnery—Figs. 31 and 32 page ix.—for small parts (H 1, 2, 3 and I 1, 2, 3), occupying the two floors over the artillery department. This department, which covers over 43,000 square feet (4000 square metres), is one of the busiest in the whole works. Nearly 450 machine tools of all descriptions are in motion here, and between 20 and 25 tons of material are worked up here every twenty-four hours by the day and night shifts. The organisation is again excellent, and production is specialised. The system of independent transmissions adopted here is noteworthy and practical. The products are taken to the "controlling room" by little electric cranes running on the single-rail system to economise space. The hands number about 450.

(4) *The Locomotive Works.*—The building of locomotives was, as we have said, the reason of Ansaldo's being, and the first Italian engine, the Sampierdarena, Fig. 30, was turned out of the works by Giovanni in 1854 under the auspices of the great Cavour, and was still shunting in Savona Station in 1906.

Fig. 35—ERECTING SHOP FOR SMALL AND MEDIUM GUNS

Fig. 36—GUN ERECTING AND FITTING SHOP

The Genoese firm, in those years, held the monopoly in Italy, but orders diminished for reasons already touched on, and the railway industry lay dormant in Sampierdarena. It was aroused in 1890, and when, fifteen years later, the State took over the companies, it sprang into action. The result has been the building of the great shops down by the Polcevera River—Figs. 33 and 34, page ix.—A, B, C, D, and E, shops which are 656ft. (200 m.) long and 171ft. (52 m.) broad, and which cover an area of 161,460 square feet (15,000 square metres).

The writer would willingly describe the works in detail, for the plant represents all that to-day's science can devise, and the organisation is excellent. These facts are not generally known. Many technical men, even in Italy, would be surprised at the completeness of the locomotive branch in Sampierdarena. Ansaldo's name is bound up with "those that go down to the sea in ships;" other manifestations of activity are, consequently, thrown into the shade. For the very reason, therefore, that Gio. Ansaldo e Co. are synonymous with the defence of the country, it is, perhaps, more fitting to devote the limited space at our disposal to their expansion and present prosperity under that aspect, merely adding that in the locomotive branch, the only other firm which can be compared to them in Italy is that of Breda, the specialists, of Milan, and that a considerable part is assigned to them in all the orders for engines given by the State railways.

(5) *The Gun Works.*—We have in the first chapter referred to the reasons which prompted Commendatore Perrone to render himself independent of outside aid. Matters, in short, had come to such a point that he had no choice but to shake himself free of the chains that bound him or to yield at discretion. His scheme for buying up the Armstrong factory at Pozzuoli could not be carried out. The conception which his sons have realised is more courageous still. Building in the neighbourhood of Genoa is no light undertaking, even for the longest purse, for the land costs about 30s. per square foot. It was on such land that a great establishment had to be erected from the ground, and provided with the plant necessary for what was destined to become the greatest gun factory of Italy. But the theatre for the future industry would have served little without the actors; and in 1910 an agreement was made with Schneiders, assuring their co-operation for a limited period, while the necessary staff of experts and workmen was gradually got together.

The choice of the method to be followed in building the weapons had been no easy one. In the first place, the wire-wound system was not discarded without the gravest thought; but, whatever may be its merits, the studies of Coupaye and Malaval in France, followed by those of Captain Ettore Bravetta and Col. Bianchi in Italy, caused Italian experts to decide against it.

The Ansaldo experts felt perfect confidence in that *sine quâ non* of gun manufacture, the quality of their steel, and Schneider's method was chosen in 1910. Hence, it will be seen that the extraordinary feat was performed of building and equipping the great armour plate and artillery works at Cornigliano and Sampierdarena in little more than 2½ years. To the former place was assigned the foundry and armour factory; to the latter, the making of the guns, since it presented the advantage of being near the mechanical department, with its highly modern plant and its nucleus of 3000 trained workmen.

The factory for medium size and small weapons is in the three-storied building, 328ft. (100 m.) long, which covers 76,424 square feet (7100 square metres) opposite the new locomotive shops. It is built in

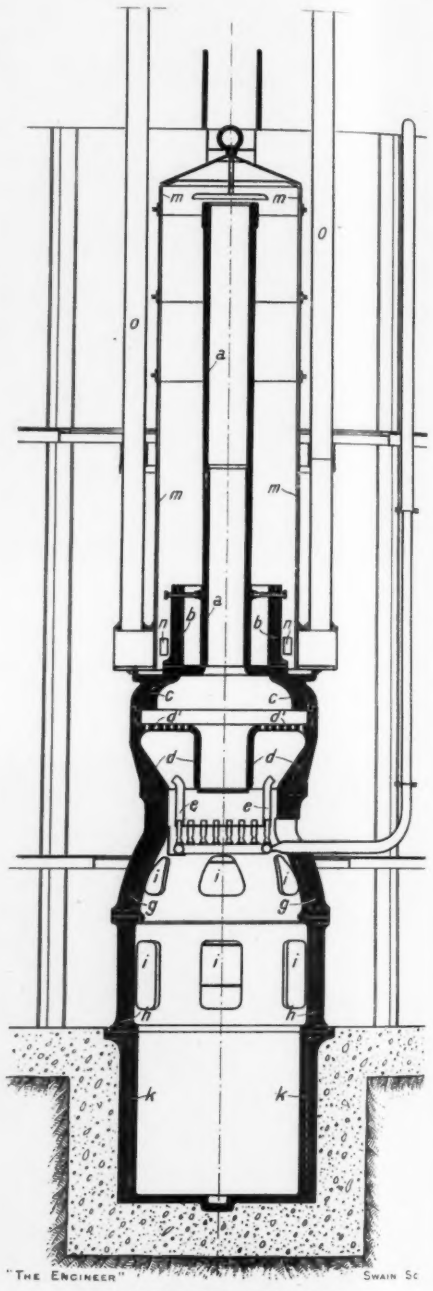



Fig. 37—SHRINKING FURNACE

reinforced concrete, with floors calculated for a weight of 512 lb. per square foot (2500 kilos. per square metre), and contains about 300 machine tools for the making, setting up, and repairing of guns and carriages. Many names of makers are familiar. Herbert, Muir, Macpherson, Fairbairn, Hulse have all contributed. There are also tools by Brown and Sharpe, of Cincinnati, the Progrès Industriel, some German firms, and, among home makers, Züst, of Intra, and Dubosc, of Turin. A deal of work is going on in naval and in land guns of 10¼in. (260 mm.), 6in. (152 mm.) and 3in. (76 mm.)—see Figs. 35 and 36—on carriages for 10¼in. mortars, and also on Girod projectiles, of which 14,000 are in construction. At the end of this shop we come to a high wooden paling, behind which the medium size and small guns are hooped.

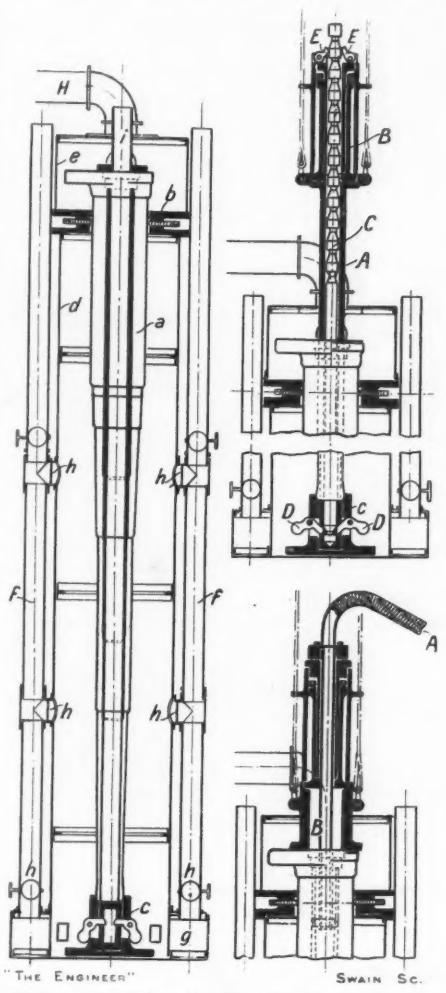
The furnace—Fig. 37—is about 23ft. (7 m.) deep; and the heating is effected by hot air, so that the flame does not touch the hoop, and inequalities of temperature and blistering are avoided. The system, which is patented, is said to render unnecessary any

plant for the straightening of guns, and certainly there is no such arrangement at Ansaldo's. Hooping began last summer, and in less than six months fifty guns had been finished. The maximum deflection registered was, we are informed, two-tenths of a millimetre in a 6in. (152 mm.) weapon. The drawing will be better understood on reference to the following explanation :—*a*, Tube to be shrunk on to the liner ; *b*, iron support to centre the tube ; *c*, chamber lined with refractory material, which collects the products of combustion from the furnace ; *d*, combustion chamber lined with refractory material, and having a perforated roof $d^1$ through which the products of combustion pass into the chamber *c* ; *e*, circle of Bunsen burners ; *g*, *h*, *k*, iron foundation ; *i*, air passages for feeding the flames ; *m*, bonnet enclosing the tube to be heated ; *o*, chimneys for escape of burnt products ; *n*, openings—four—to latter.

Three other drawings show the "Sanvenero" method of relining. In Fig. 38 the gun *a* is supported by a ring *b* and the footstep *c*, both of cast iron, and is shut into a jacket lined with refractory material. The jacket communicates with two chimneys *f f* by means of a chamber *g* and six dampers *h* are fixed at various points in the jacket. The hot gases coming from the furnaces—not shown—enter by the tube H, envelope the outer part of the breech, pass through the ring *b*, turn towards the bottom end, and, traversing the footstep, act on the inside of the gun. They then pass out through the chimney *i*. When the chase of the gun, being thinner than the breech, has arrived at a temperature of about 250 deg. Cent., the damper of the chimney *i* is shut, so that the gases no longer pass up the centre of the gun, and the dampers marked *h* are opened in such a way as to regulate the exterior heating.

Fig. 39 illustrates the operation of putting in a new liner. When the gun, heated in the above manner, has arrived at the necessary temperature, a trap-door in the cover *e* is opened, and the new liner is lowered by the crane. A 20-ton hydraulic press B is applied to the liner A and into the inside of the tube a bar C, cut with a series of notches, is passed at the upper end, and with one notch at the lower. This bar being longer than the liner is held fast at the bottom end by two catches D D mounted in the footstep *c*. In the meantime the press and liner continue to descend. Should the motion cease, as may happen in the last moments of the operation, the press comes into action. Its cylinder then rises, and the two catches E E fastened to it close on one of the notches of the bar C. The liner is thus forced into its place, and the press is kept in action until the gun is cool, so as to be certain that the shoulders in the liner and the inside of the gun are in perfect contact.

Fig. 40 shows the extraction of an old liner. The gun is heated as before, but the hot gases are not allowed to have access to the inside. When the gun is at the right temperature a jet of water from the pipe A is opened inside it, and at the same time the press is brought into action, its cylinder being joined to the liner by a pipe B. It therefore follows that the press will begin to work at the same moment that the cooling permits the liner to move. The final extraction is done by the overhead crane, to which the press is suspended.




Figs. 38, 39, and 40—APPARATUS FOR RELINING GUNS

The large guns, carriages and armoured redoubts are made in the new building—X, Y, Y *bis*—which is in reinforced concrete, and has taken the place of the old iron foundry removed to Cornigliano. It is opposite the principal entrance where the visitor first came in. The shops are 558ft. (170 m.) long by 138ft. (42 m.) broad, and are divided into three naves served by cranes of 80, 40 and 10 tons lifting power. They contain many splendid tools. Among these may be mentioned a Breuer Schumacher lathe, weighing 220 tons and measuring 5·2ft. (1·60 m.) height of centres and 66·5ft. (20·3 m.) between centres ; a 48in. Hulse lathe, of 72·2ft. (22 m.) long, and weighing 150 tons ; a Hulse grinder for guns up to 17¾in. (450 mm.) diameter ; two Hulse boring machines with 52in. bars and 66ft. traverse ; a Fairbairn-Macpherson rifling machine, for guns up to 17¾in. (450 mm.) bore ; and others. There are also 227 machine tools bought lately at a cost of £60,000 for the making of the armoured redoubts. The sections are all linked up by railway lines to the rest of the works and to the station. A special line connects the department where the big weapons are made with the plant for building them up.

The shrinking plant for big guns K—Figs. 42 and 43—consists of a great iron shed, 72ft. (22 m.) long and 53ft. (16.22 m.) broad. At the height of 78·7ft. (24 m.) are placed the guide rails for a travelling crane to lift 150 tons, or 20 tons with the auxiliary hook. The whole is closed in from every side. The pit is 59ft. (18 m.) deep and 21·3ft. (6·50 m.) broad at the top part, and 11·4ft. (3·50 m.) at the bottom. The plant is therefore able to take guns of considerably larger size than those used at present. The principle followed is the same as that already described for small guns. The hot air, coming from a coil in a special furnace by the side of the shed, is pumped into the pit by two fans of a capacity of 31,783 cubic feet (900 cubic metres) under a pressure of 1 m. of water, and after having warmed the hoops, passes under the grate, thus forming the forced draught of the furnace. A network of piping and valves, with an arrangement for the water cooling, and a recording thermo-electric pyrometer go to complete the plant.

The last unit of this part of the works which remains to be noticed is the turret erecting shop M, an iron building 328ft. (100 m.) long and 64ft. (19·50 m.) broad, with a height of 46ft. (14 m.) from the floor to the guide rails of the two cranes of 80 tons lifting power, with subsidiary hook of 20 tons. A crane of 120 tons lifting power will shortly be added. The four great pits—see Fig. 41—are over 23ft. (7 m.) deep and vary from 23ft. (7 m.) diameter at the top to 13ft. (4 m.) at the bottom. Great difficulty was experienced in making them owing to the nature of the ground, and the work, performed with pneumatic caissons, progressed sometimes at the rate of only 1½in. per day.

The drawing of a 15¼in. double gun turret accompanies this description of the factory, and also one of a 3in. quick-firing gun for scouts now being made for the Chinese navy. The turret—see Supplement—is entirely armoured in its upper part. The closing of the breech mechanism can be effected

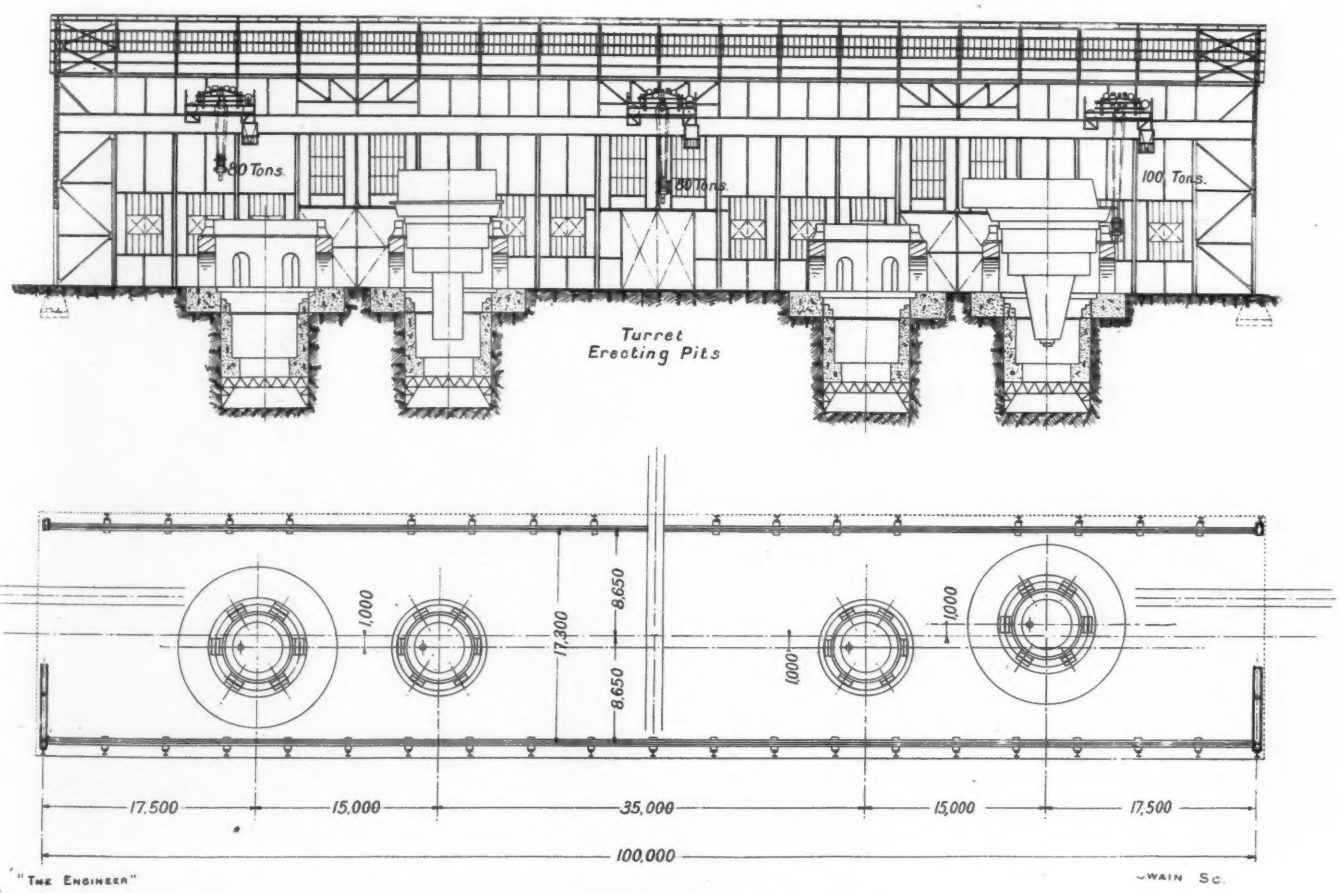



Fig. 41—TURRET ERECTING SHOP

by hand or electricity, and there is provision against the danger of unexploded charges and against those which may explode prematurely. The weapon is loaded in a fixed position of + 5 deg. The brakes fixed to the cradle are on the familiar hydraulic system. The compressed air running-out cylinders are situated in the ring fixed to the breech of the gun—see Fig. 44. Firing is effected electrically by percussion. Each weapon is fitted with a smoke-ejecting apparatus, which forces a current of air under pressure into the gun during such time as the breech remains open. The air supply can be regulated, and is furnished by a battery of air bottles in the turret. The training of the gun is electric, with two stand-bys, one electric and the other hand-operated. The projectiles are conveyed by a continuous belt conveyor on to a turntable from which they are slid into the trays of the lower hoist. The charges are transported in the same way, save that they are carried by hand from the belt conveyor to the hoist trays. A full description of this mounting is rendered impossible by lack of space, but the drawings, so courteously lent by Ansaldo's, speak for themselves.

The 3in. 50-calibre quick-firing gun is also of the built-up type, and is composed of a liner reinforced by hoops for about two-thirds of its length—see Fig. 45 and page xiv. The breech mechanism is on the cylindrical screw principle with interrupted threads. The pedestal is made a cast steel cone, having on the top the gear ring for training the gun. At the bottom of the pivot is a ball bearing. The aiming mechanism is to the left of the cradle, and is composed of the ordinary sight, of the sight with "Ross" finder, and of the usual range and deviation mechanisms. It has electric lighting for night work.

The practical way in which the railway system is organised throughout the whole establishment is particularly noticeable in the gun factory. The offices of the representatives of the various Governments who have orders running with the firm are situated in this department, for which a special autonomous management has been created. To the vice-director, Ing. Camillo Manzitti, I take this opportunity of tendering my most hearty thanks for the invaluable help that he has afforded me during weeks of work together.

(6) *Lighting of the Works.*—The electricity for lighting Ansaldo's establishments was formerly made by the firm, but is now contracted for with the Società Negri. A sub-station has therefore been built near the Cornigliano Bridge on the Polcevera River, and the current is stepped down from 70,000 to 12,000 volts. It is then transmitted to Sampierdarena by two three-phase armoured cables buried at a minimum of 1 m. These are led to a cabin where a part of the current is again stepped down by two static transformers of 350 kilovolt-ampères each to 220 volts for the artillery works and small lathe shops. Another part is transformed in the old steam central station into continuous current at 220 volts, with neutral wire at 110 volts, and is transmitted to the switchboard, and thence to the various sections of the works. The continuous current is for the machine tools, driven by motor and having electric speed variation. A third cabin steps the 12,000-volt current down to 220 volts, and distributes it in alternating current. There is also a fourth transformer of 350 kilovolt-ampères in the locomotive erecting shop near the air compressor motor.

The open spaces and shops are lit with arc lamps. In the shops they are hung on parallel wires and in triangles at 66ft. (20 m.) one from another. They are of the enclosed type, of about 1400 candle-power, and burn for 100 hours with one pair of carbons. Their consumption is 0·35 watt per candle, including the energy consumed in the different resistances. The use of incandescent and metallic filament lamps is limited to the smaller shops. Each tool has a separate switch for use with a portable electric lamp

## CHAPTER III.—CORNIGLIANO LIGURE.

(1) *The Laboratories.*—The suburb of Cornigliano Ligure lies by the Polcevera River, about a mile north of Sampierdarena. Here it was that, in 1898, Ansaldos first built their steel works, for Cornigliano offered a great advantage, the possession of that rare article of commerce in these parts, a little open space. The visitor on entering is usually conducted to the huge shop where are the foundries, the presses, and the hammers. We, however, may be permitted to cross through it without stopping and first visit the research laboratory—see Figs. 46,

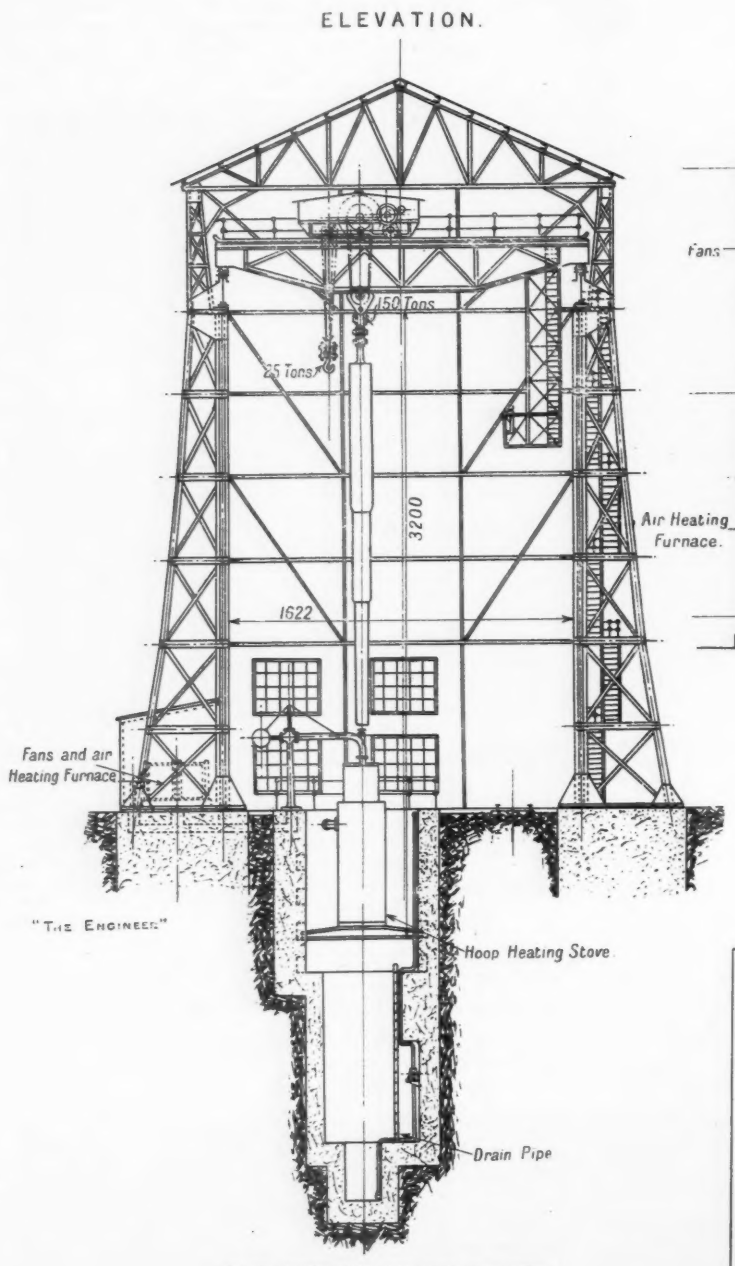



Fig. 42—SHRINKING PIT FOR BIG GUNS

Fig. 43—SHRINKING PIT FOR BIG GUNS

47, and 49. To describe at length this important factor of Ansaldos success would be far beyond the limits we have laid down for ourselves. We are therefore reluctantly obliged to summarise. It may be said that each room in the house represents a separate process, and each is furnished with the newest implements. There are twenty Corleis apparatus for the determination of carbon, there are electric furnaces, there are Nolly and Wiborg appliances, there is a whole series of Eggertz tubes. For the determination of sulphur the Rollet-Campredon apparatus is used, modified according to the experience of the laboratory. For the taking off of the gas from the producers with a view to analysis the Gerick vacuum pump is adopted; another room is furnished with the appliances for electrolysis. A Berthelot calorimetric bomb, as improved by Kroecker, is used for testing calorific value and analysing the gases derived from the combustion of liquid fuels; for analyses of coal and for comparative analyses Thompson's calorimeter is preferred. An Engler viscosity meter, with oil bath for high temperatures, serves for the determination of the qualities of oils for cylinders and turbines, the viscosity of the latter being tested at rises of 18 deg. Fah. (10 deg Cent.) from 68 deg. to 302 deg. Fah. (20 deg. to 150 deg. Cent.). Another appliance gives the densities at different temperatures, and so establishes a rule for reckoning the capacity of tanks on warships.

The micro-photographic department is furnished with a Koritska microscope arranged for the direct illumination of opaque objects. Another instrument expressly constructed by Reichert, of Vienna, serves for the observation and photography of the microstructure of metals. This latter takes pieces of comparatively great weight and size, and affords the view of a large section of the structure. It is therefore useful for the observation of parts of projectiles, armour, and similar unwieldy objects. The revolving mechanism with which it is fitted permits of the immediate change of the object glasses and the variation of the enlargements from 30 to 3000 diameters.

For the physical tests the laboratory is provided with a Thompson's double bridge for the determination of specific electric resistance, a Picou permeameter for establishing magnetic permeability, and an apparatus of Saladin Le Châtelier, with Broniewski modifications, connected with an electric furnace for the precise determination of the critical points of various steels in the various conditions of working. This instrument gives an exact account of the critical temperatures. The entirely new scientific basis on which the application is founded has formed the subject of several publications.

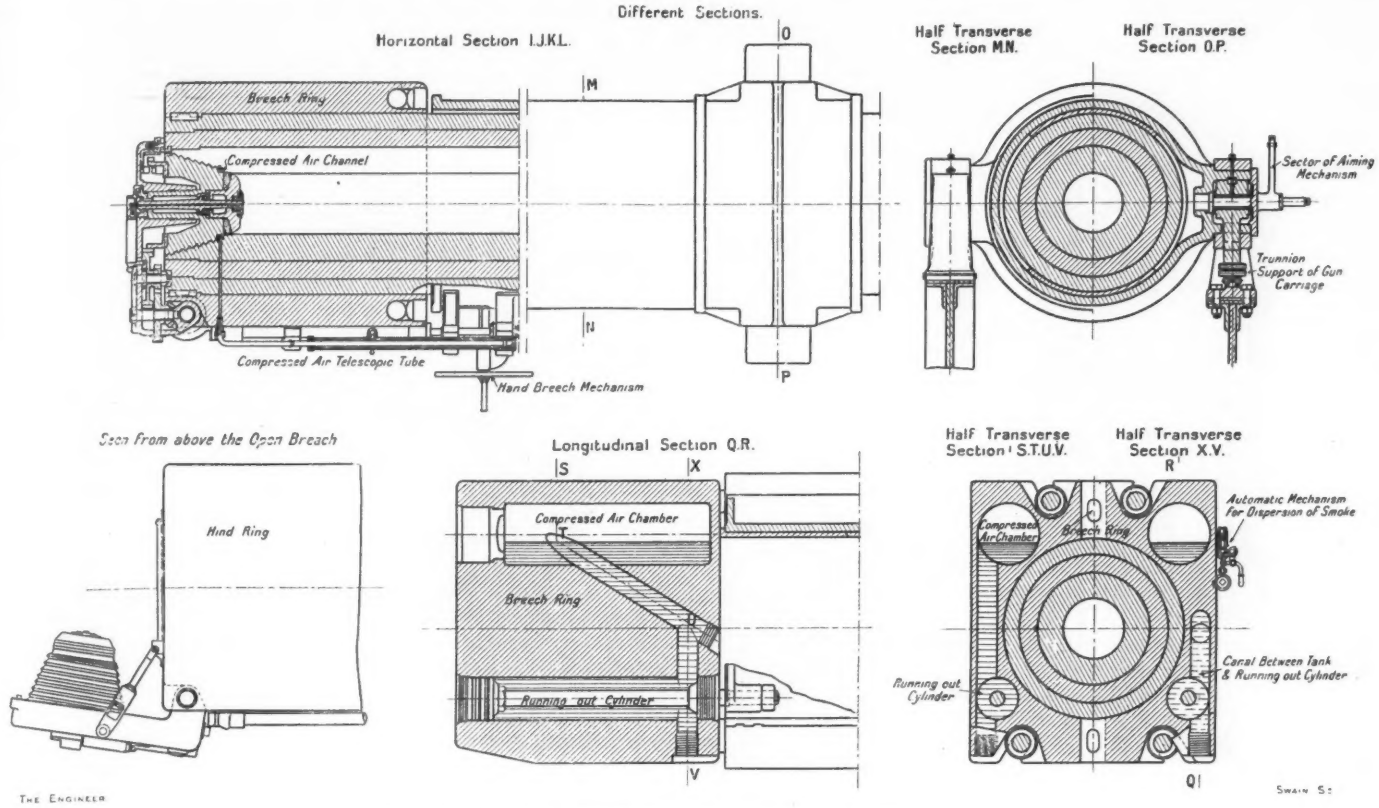



Fig. 44—DETAILS OF RUNNING-OUT GEAR, BREECH MECHANISM, ETC.

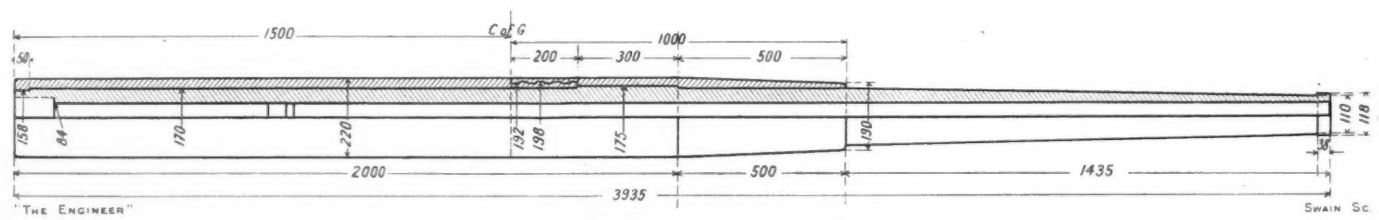



Fig. 45—LONGITUDINAL SECTION OF 3-INCH GUN

Among the many noteworthy instruments for the mechanical tests is a 100-ton autographic hydraulic machine, made by Amsler, of Schaffhausen, for tension, compression, bending, shearing, and Brinell's ball tests. There is also a Charpy

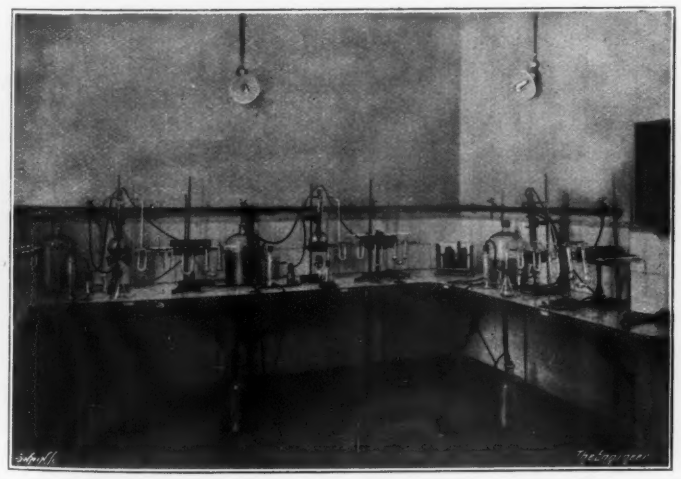


Fig. 46—CORLEIS APPARATUS FOR ESTIMATING CARBON

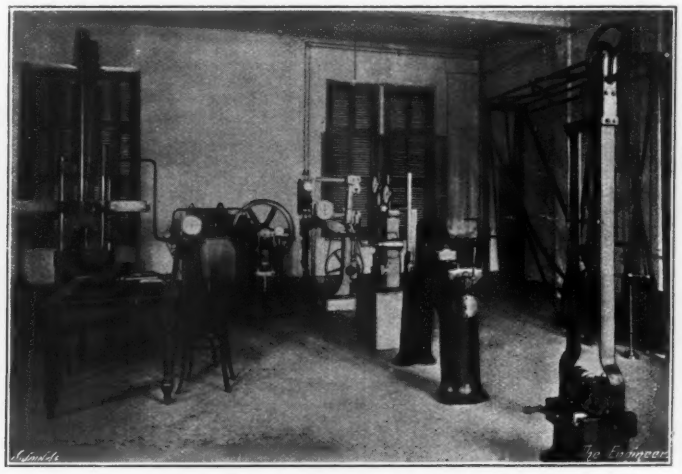
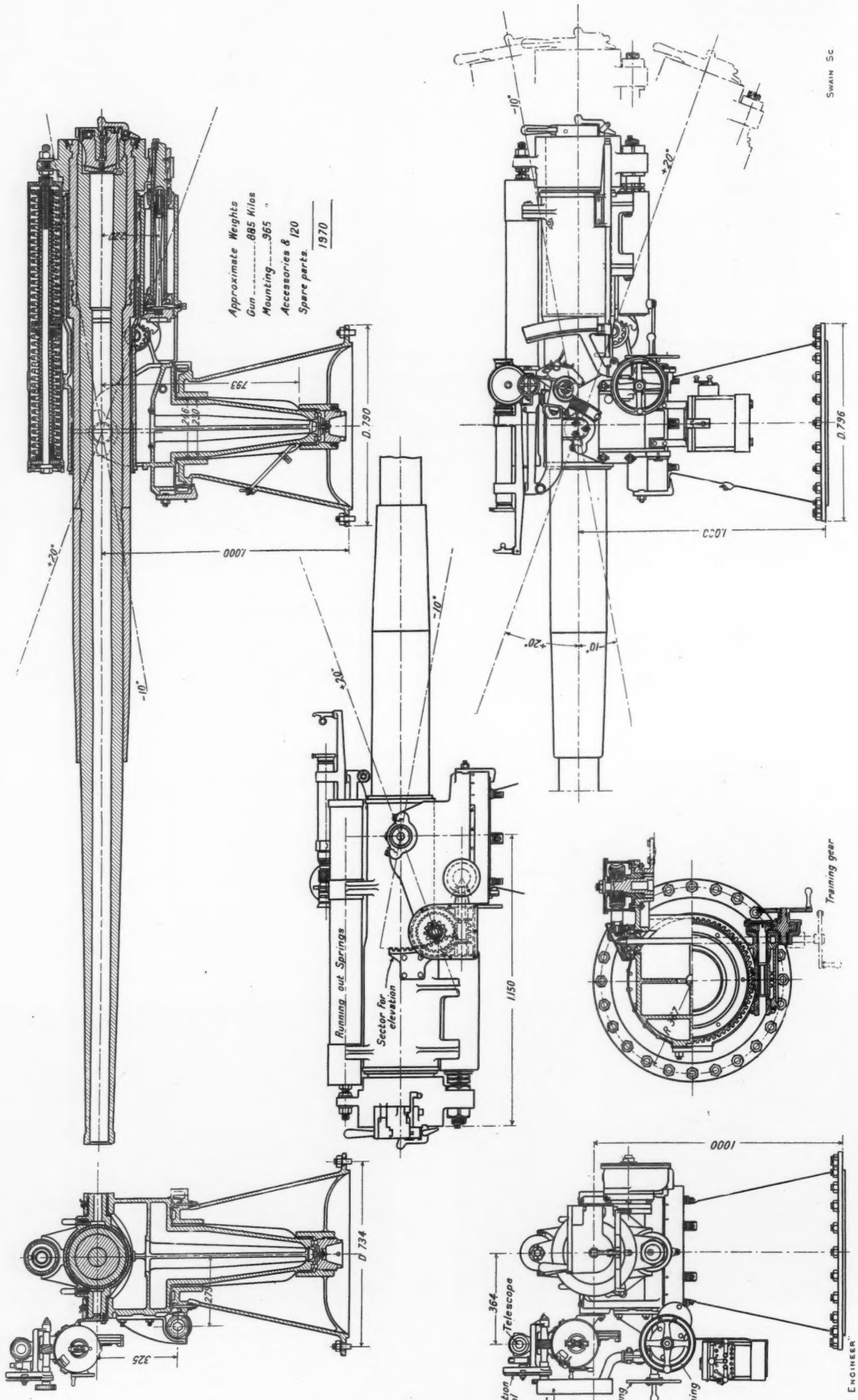


Fig. 47—MECHANICAL TESTING APPARATUS

pendulum with a 1.96 cwt. (100 kilos.) tup, and a Guillery rotative hammer, also for impact tests, by Cail, of 3.93 cwt. (200 kilos.). A Marten's extensometer, made by Amsler, gauges the elongation of the test pieces up to the tenth of a thousandth of a millimetre, and a Brinell machine determines the depth of the ball impression in hundredths of a millimetre.

# 3-INCH 50-CALIBRE GUN AND MOUNTING



This latter method of testing has been brought to great perfection at Ansaldo's. They have, in fact, constructed a portable apparatus—see Fig. 50—with which they get results near enough to enable them to judge if the piece should be treated afresh or if it should be re-tested with other machines.

There is also a rotating fatigue test machine, which tests two pieces at a time, and a hammer alternating test machine, which acts longitudinally.

The most important office of the laboratory is to control the working of the steel foundry and of the armour plate section. This control begins with the light requirements, constitute, nevertheless, an important factor on account of the varied nature and good quality of their products. For several articles—among others turbine blades and brass strip—there is no one in Italy who can equal Ansaldos; in propellers for ships, from the super-Dreadnought downwards, they enjoy an uncontested monopoly.

The works occupy themselves with copper and its numerous alloys, as well as with bronze, brass, zinc, pewter, and aluminium, but their care is especially devoted to the infinite forms of that Proteus-like composition based on the formula Cn + Zn + Fe, rapid progress of the new science soon rendered it necessary to keep pace with or, better still, to precede the movement. Enlargements were therefore begun in the little workshop in 1907, and followed each other every two years until the establishment became what it is at present, a complete electrical manufactory which designs and builds machines of every description, covers 20,000 square feet (1860 square metres) and employs over 500 workmen—see Figs. 55 and 56.

It would have been interesting to give designs of some of the principal machines made, but as yet

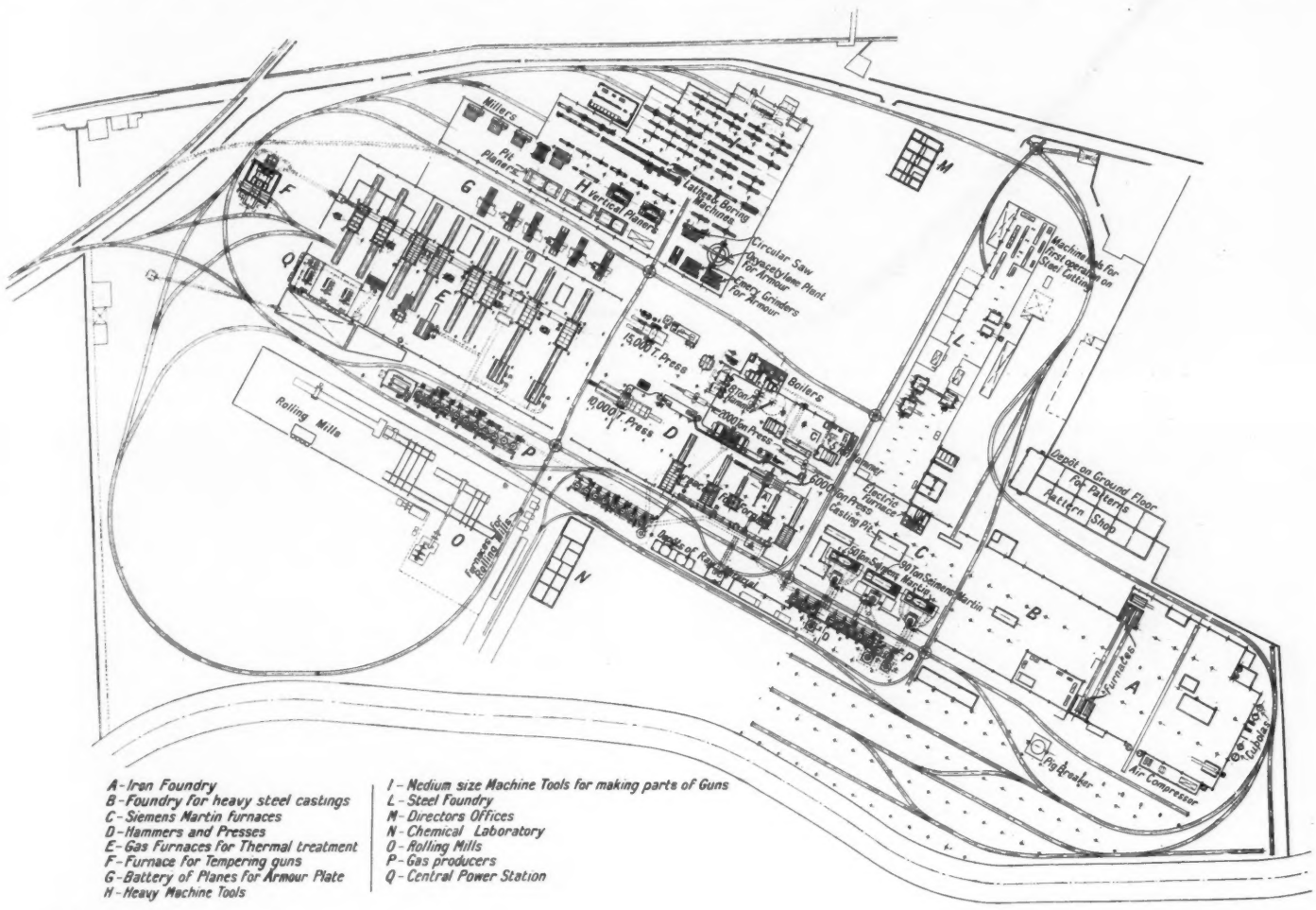



Fig. 48—THE STEEL WORKS AT CORNIGLIANO LIGURE

charging of the furnaces, and continues during tapping and subsequently. A test-piece from each of the tappings of ordinary steel given by the acid and basic furnaces is sent to the chemists, and the verdict is pronounced within the day as to the nickel, chromium, carbon, manganese, silicon, phosphorus, and sulphur contained in it. In the case of guns and armour plate the test-pieces are sent for every phase of the tapping operation, and trials are made by methods allowing of the greatest rapidity, which enable the engineers to keep pace with the gradual development of the process. Basic and acid slag are also examined, and

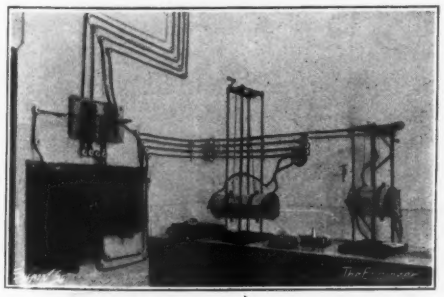


Fig. 49—ELECTRIC FURNACES

the analysis in this case also is contemporaneous with the tapping itself. In short, the chemist's life at Ansaldo's is certainly no sinecure.

(2) *The Delta Metal Works.*—The Delta Metal Works—see Figs. 51 to 54, page xvi.—represent the first acquisition made in Cornigliano Ligure, since they were bought up from the Società Italiana Delta in 1894, four years before the purchase of the land for the first steel foundry marked the growing energy and prosperity of the firm. Since then they have been enlarged, and, though not on the same high level of excellence as the other establishments from the modern standpoint of space and which goes under the name of Delta metal. The establishment possesses a pattern shop with plant for wood working, and a foundry divided into two sections, one for small and one for large work. The forge shop for the treatment by the cold and hot processes of the various compositions, is fitted with furnaces, breakers, and hammers of various forms and dimensions. There is also a mechanical section, with its usual accompaniment of drills, planes, and milling machines, a separate department for the casting, machining, and finishing of propellers, and another for drawing wire with diameters which range from $\frac{1}{32}$in. (1 cm.) to the $\frac{1}{250}$in. (one-tenth of a millimetre). The rolling mills are divided into those for sheet and those for sections and bars. There is a modern machine here of special type for the working of strips and bands.

The most important department in this establishment is, however, undoubtedly that of the presses for the extruding by hydraulic power under the "Dick" process of bars, sections, and angles of a great variety of shapes. Over five hundred of these patterns are now in commerce, and are used as mouldings for carriages, frames, and furniture. Other specialities are packing pieces and bars for turbine blades, some of which latter do credit to the firm by the fineness and depth of the taper edge and the absolute soundness of the metal. Segments for commutators of dynamos and motors, which are worked to the one-thousandth of a millimetre, are also made, and for the classifying of them special steel gauges are kept. The "Dick" press, which also makes round bars not under $\frac{1}{4}$in. (6 mm.) diameter, turns yearly out of Ansaldo's works at Cornigliano finished products of various sections to the amount of 1500 tons.

(3) *Electrical Manufacturing Department.*—The electrical works were started in 1900 on a most modest scale. They were not intended for independent commercial transactions, but merely as an auxiliary workshop to fit and erect the various electrical contrivances, which were then beginning to be introduced on board the ships being built or fitted out by the firm. Such contrivances were at that time practically limited to bells and lighting, but the originality has shown itself almost entirely within the sacred precincts of a battleship. The commercial side appears to have been less deeply studied, though the firm makes generators, motors, rheostats, cranes, and winches, and fits out complete central stations. There is nothing, however, remarkable about these familiar objects, and particulars would therefore be superfluous; while in the case of naval appliances a general description—which must inevitably assume more or less the uninviting form of a catalogue—is all that can be given.

The machines which especially attract attention are those connected with steering gear—Figs. 57 and 58

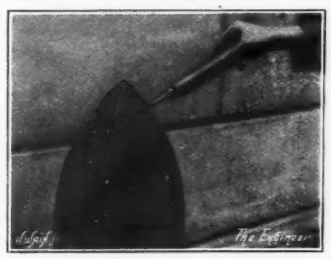


Fig. 50—PORTABLE HARDNESS TESTER

—and artillery. In these sections Ansaldo's may be said to be not only in the first line, but pioneers besides. By dint of continual improvements they have been able to obtain excellent results at very low speeds in the revolving of turrets, the motion being uniform and perfectly under control. The turrets of the Dante Alighieri, which have electrical plant merely as a stand-by, possess a ratio between maximum and minimum speed of turning of 1 to 300, and the same on the elevation of the gun. In the new ships the ratios of 1 to 400 will be reached. The Regina Elena's turrets, after eight years' continuous service without a breakage, work with the same smoothness as at first.

The electric gear of the rudder of the Dante was a complete novelty. The trials took place during a prolonged voyage and in rough weather; yet the maximum error found was only the tenth of a degree. On the later-built ship, the Guilio Cesare, an improvement was made. The gear is operated by electricity, steam, or hand, and acts both on the rudder and on the auxiliary rudder too, if the latter be required for a brisk evolution. The helmsman, by turning the two wheels together in the same direction, obtains on the helm a steering effect which is the sum of the effects of the two methods. The electric gear, placed on the starboard side, consists of a rotary transformer of 110 volts, 1600 ampères, and 450 revolutions, which transmits a current of 1400 ampères at 105 volts to the motor. It can also act independently in case of damage. The steersman on the bridge sets the helm to the number of degrees ordered, the motor comes into action, and the number of degrees indicated is instantly registered by a controller, which shows that the helmsman has understood the command. The motor in the meanwhile moves the rudder till the number of degrees of turning has been completed, when an automatic brake puts a stop to its action. The steam gear on the port side is of the Forester type, while the hand apparatus acts by means of a fourfold reduction gear on the principal shaft. An analogous arrangement—see Fig. 58—on submersibles allows of the change from the electric to the hand gear without any sort of interruption in the manœuvre, and has been adopted by the Italian and German Admiralties.

Long-distance control on board ship, with the consequent command from the bridge of the turbines or the engines, is the subject which is at present engaging the attentions of the firm. The first trials have been completely successful. Systems for the training of guns from a distance so as to enable the "director" to do the aiming and firing himself are also being investigated. The first step made by Ansaldo's towards the solution of the problem of long-distance control was represented by their ship-telegraphs, which work with absolute precision.

The above are some of the most important electric appliances as yet designed by the firm; to continue would be merely to enter upon a list of every object on board a modern ship to which electricity has as yet been applied.

(4) *The Iron Foundry.*—The iron foundry—see A, Fig. 48—forms one of the extremities of the steel works, has a covered area of 64,583 square feet (6000 square metres), and consists of three bays furnished with electric travelling cranes running on lines which are a prolongation of those of its big neighbour. Big it may called without exaggeration, for the total length of the new building is no less than 1600ft. (487 m.). The shops are made as a continuation one of another for the purposes of rational division of labour and economic production. Celerity in handling is also furthered by the practical arrangement of the cranes. There are five of these in the three bays, ranging from 30 to 10 tons lifting power and they are so placed that they can be used to help one another. There is no spot in the section which their hooks cannot reach. There are also electric jib cranes fixed to the columns and made detachable so as to be easily transported from one column to another as there is need of them.

At the end of the central sheds are four cupolas, coupled two and two, of an hourly capacity ranging from 3 tons to 20 tons. The 20-ton cupola has a receiver for 15 tons, while a centrifugal high-speed fan driven by an electric motor gives the blast. The furnace by its side of 8 tons capacity, and with similar system of draught, has a receiver for 7 tons. The throats of these two double cupolas are on a level with the ground, so that the charging can be done from the same platform. A vertical electric lift raises the iron and coke. The two furnaces work together or separately, and can prepare enough molten iron for the heaviest cast. The casting pit is of reinforced concrete with a capacity of 17,657 cubic feet (500 cubic metres).

The medium casts are made in the two eastern spans, where there are two cupolas of 3 tons and 5 tons capacity, with their throats on the same level and with forced draught produced by rotary fans. The casting pit in this case measures 3531 cubic feet (100 cubic metres).

Two other cupolas, each of 2 tons capacity per hour,

Fig. 51—PLATE ROLLS AT THE DELTA WORKS

Fig. 52—ROLLING MILL AT THE DELTA WORKS

Fig. 53—THE FOUNDRY AT THE DELTA WORKS

Fig. 54—DICK EXTRUDING MACHINE

Fig. 55—ELECTRIC MOTOR DEPARTMENT

Fig. 56—MACHINE SHOP—ELECTRIC DEPARTMENT

are to be seen in the west bay. They have one fan between them, a vertical electric lift, and one chimney shaft having its origin in a spark chamber constructed on the charging platform, which unites the two furnaces. The moulding boxes and large cores are dried in separate stoves, of which there is a group of three different sizes in the east bay, placed opposite a fourth stove of large capacity. This latter is in the west shed, and they are all linked up by two lines running across the foundry. Any of the travelling cranes in the various bays can therefore be used for carrying the moulding boxes or the cores to the stoves most fitted for their size.

The moulding sands are prepared by an automatic apparatus of the newest type, which unites in itself the various machines for the treatment of the new and used sand, the grinding, sifting, mixing, &c. The fettling of the castings is done with pneumatic tools, all of which are supplied by a central compressor.

The usual composition of the iron for ordinary castings may be roughly stated to be Eglinton and scrap. This latter, when used for turbine cases, is carefully selected. The recipe adopted for Diesel cylinders has already been given under that heading. In the case of locomotive cylinders the formula is C 3.5, Si 1.15, Mn 0.87, P 0.30, S 0.028, and the tensile strength is 31,291 lb. per square inch (22 kilos. per square millimetre). The annual production of iron castings in this section is calculated at 5000 tons.

(5) *The Steel Foundry.*—The steel foundry, built, as has been already said, in 1898, began its work immediately by making all the steel castings necessary for the battleship Regina Margherita. The complicated nature of some of these parts and the quality of the work produced told their own story, and Ansaldo's took at once a first place among Italian steel works.

The area occupied was then only about 32,292 square feet (3000 square metres) It is now nearly double that size, or, to be exact, 55,972 square feet (5200 square metres). A basic Siemens-Martin furnace served for the melting of the steel. There was also a Krupp crucible oven. But this latter was taken away later on, and was substituted by a second Siemens-Martin furnace, identical with the first. The nominal capacity of each of these furnaces is 6 tons, and the output 24 tons of steel in the twenty-four hours; but in reality they have often been called upon for 8-ton casts. Their status, however, may be said to have diminished since the birth of their three younger but much larger brethren—two 50-ton furnaces and one of 90 tons.

The new steel foundry—see B Fig. 48, Figs. 59, 60, 61, 62 — forms part of the same huge workshop already spoken of, 1600ft. (487 m.) long. The "casting" section employs over 200 hands. There are the usual drying stoves, a shop for the preparation of sand, the hand and pneumatic fettling shops, and the emery grinding department. Castings are sent out either rough, half-machined or finished. A small quantity of ingots is also produced by this section. The annual average production of castings is about 7000 tons, ranging in size from the smallest to the very heaviest known. For these latter, however, use is made of the new Siemens-Martin furnaces — C Fig. 48. These are three in number, two being of 50 tons capacity and one of 90 tons — see Supplement. They are easily able to turn out between 800 and 900 great ingots yearly, and, calculating on a basis of 300 working days, the shop can account among its other assets, for providing the material for

Fig. 57—STEERING GEAR FOR A BATTLESHIP

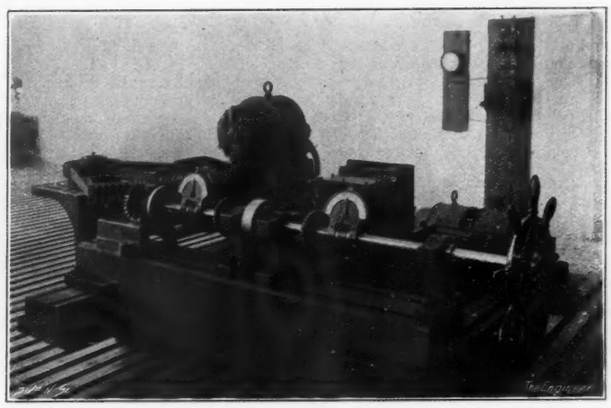


Fig. 58—STEERING GEAR FOR A SUBMERSIBLE

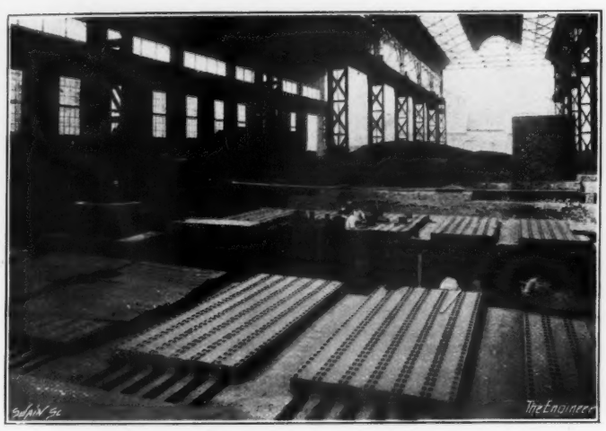


Fig. 59—REGENERATOR UNDER CONSTRUCTION

Fig. 60—GIROD ELECTRIC FURNACE

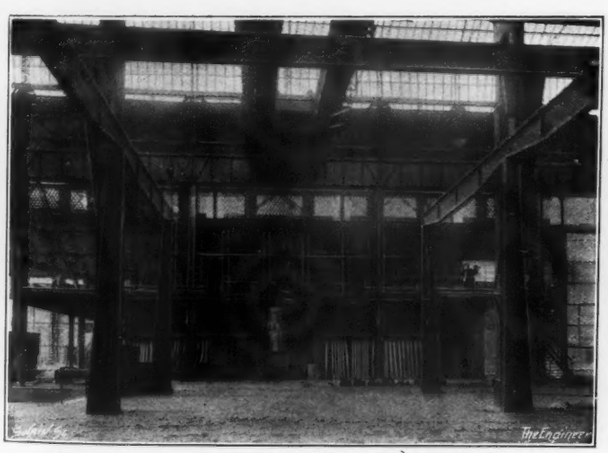


Fig. 61—50-TON SIEMENS-MARTIN FURNACE

Fig. 62—FURNACE CHARGING MACHINE

an annual production of 15,000 tons of armour plate completely finished. The furnaces are of normal type, with regenerators, and are charged by a Wellman automatic electric charging machine, taking 3 tons at a load. They are fed by a battery of eight gas producers—see Fig. 63—placed in series with those used for the thermal treatment furnaces in such a way that they can all be served by the entire number of travelling cranes in the bay. The collectors of the single batteries of gas producers are also arranged so that each of the batteries can be isolated from the others, and can be made to supply one or more of the groups of furnaces. This system, by conferring great elasticity on the plant, increases its efficacy and entails other advantages of safety and continuity of working in all the furnaces. The same provident thought characterises the arrangement of the coal transporters, each of which is made to serve all the coal depôts and all the producers.

By the side of the Siemens-Martin furnaces is a room where the various phases of the melting operations are checked on the spot, the doses prescribed, and some of the mechanical tests applied. Parallel with this is the open space for the preparation of the charges. These are brought from the depôts of raw material, which are linked up with the State Railways, and after having been dealt with by the breakers and shears are carried by a travelling crane up to the charger of the furnaces. There are three casting pits, one for small ingots, another for those up to 50 tons, and a third for ingots of 120 tons and over. Situated above this latter there is an appliance for the placing of the casting ladles of a like size. This plant enables the casting to be made simultaneously from two ladles fed by two or more furnaces, an arrangement which renders possible the casting of the largest ingots.

A Girod electric furnace—Fig. 60—is to be seen just opposite. It has a normal capacity of 4 to 6 tons, and is fed by a three-phase current of 50 periods at a tension of 80 volts. A casting pit for small and medium castings, projectiles and tools adjoins it. The office in the space adjacent contains a frequency transformer of 340 kilovolt-ampères, of the Jacoviello type, for the combating of "piping" and phenomena of liquation in the solidifying ingot. The central bay of the steel works is served by travelling cranes of 50, 60, 80, 120 and 200 tons lifting power. The 60-ton machine is furnished with hooks of 10 and 15 tons for rapid movements. Owing to the immense size of this shop, it is impossible to give a general drawing which would be of any value, but the plan and views may give some impression of its dimensions.

(6) *Hammers and Presses.*—Passing from the steel works we come to another section of the vast building—D, Fig. 48. It is made up of four bays, 492ft. (150 m.) long and 59ft. (18 m.) broad, and is the immediate continuation of the "hall of the furnaces," from which we have just come.

The central bay, 65ft. (20 m.) high, is occupied by the great presses and their furnaces. The adjacent spaces are occupied by other furnaces, smaller presses, hammers, and boilers belonging to the department. The ingots are carried from the steel works by the cranes already mentioned up to the gas furnaces, of which there are ten, with fixed and movable bottoms. Each of these has a capacity about three times what has been the rule as yet for similar purposes, and all are fitted with motors for the rapid opening of the doors and also for removing the bottom for thermal treatment. They can all be heated to any temperature, and can therefore be used indifferently for reheating, annealing, tempering, or cementation. For the forging of large pieces there are three hydraulic presses of 1200 tons, 6000 tons, and 10,000 tons, while a fourth of 15,000 tons is for bending operations. The 6000 and 10,000-ton presses have complete and rapidly interchangeable gear so as to enable them to forge, bend, or correct.

The 6000-ton press has a movable crosshead with 6ft. 6in. (2 m.) stroke, thus allowing the welding on the mandril of large gun hoops, &c. The lateral withdrawal of the anvil is effected hydraulically, the ingot is handled by longitudinal arms, and a vertical hydraulic cylinder at the side of the press gives the rotary movement. Two roller tables, inclined towards the anvil and served by travelling cranes of 80 and 120 tons lifting power, are for the forging of armour plate. This is pushed under the hammer by two horizontal hydraulic rams, while the horizontal rotation is imparted by resting the plate on the head of a hydraulic cylinder with vertical axis round which the said cylinder rotates. This cylinder is placed between the two roller tables, and has its head free on the lowering of the roller table. The hydraulic pressure is 1470 lb. to the square inch (100 atm.) and the water is drawn from a station near the press, furnished with a triple electric-driven 100 horse-power reciprocating pump, whose regular working is ensured by a 176-gallon (800 litres) accumulator with a 16ft. 5in. (5 m.) stroke, and charged with cast iron plates of about 110 tons weight. The high-pressure linder communicates with a vertical steam compressor composed of an upper steam cylinder of about 6ft. 6in. (2 m.) diameter, with plungers in a hydraulic cylinder placed in the same line and underneath in a pit. The water is thus pressed to 8529 lb. to the square inch (580 atm.) and the distributors allow of successive strokes, variable up to 7·8in. (200 mm.) being transmitted to the crosshead.

The 10,000-ton forging and shaping press stands in the same bay. It is similar to the one already described, with the exception of the cross bar, designed for plate bending, and the fact of its possessing two compression cylinders working at 8530 lb. per square inch (580 atm.). The steam compressor is therefore the double of what it is in the 6000-ton press.

The 15,000-ton bending press is in the opposite bay. It has two hydraulic cylinders placed in the bottom part and a special arrangement for the removal of the anvil. A hydraulic plant with long-distance control by means of water with a pressure of 735 lb. per square inch (50 atm.) is provided for the secondary movements of handling the plates. In the drawing of the 15,000-ton press—see Supplement—the functions of the parts are as follows:—

(1) Lifting cylinder of intensifier. (2) Main steam cylinder of intensifier, diameter 47¼in. (1200 mm.), stroke 63in. (1600 mm.), steam pressure 176.5 lb. per square inch (12 atm.), water pressure 9294 lb. per square inch (632 atm.). (3) Hydraulic pressure cylinder of intensifier, pressure 9294 lb. per square inch (632 atm.). (4) High-pressure water pipe. (5) and (7) Hydraulic cylinders. (6) Ram head with spherical seating. (8) Pipes to balancing cylinders of crosshead. (9) Motor operating lifting gear of crosshead. (10) Cross head. (11) Rotating nuts for raising crosshead. (12) Main columns. (13) Balancing cylinders of crosshead.

The section "hammers and presses" includes, besides others, an 8-ton steam hammer served by a small gas furnace—a self-contained plant with gas producers. Finally, there is a large 100 horse-power air compressor working at 103 lb. to the square inch (7 atm.) and connected with the system of piping in the workshop which drives the pneumatic hammers for the fettling of the armour plate.

The presses, it will be gathered from these brief notes, represent one of the most remarkable features in these remarkable works. Some of these furnaces and presses are illustrated by the reproductions of photographs—Figs. 64, 65, 66, and 67, and on page xxiv., and by drawings given as a Supplement.

(7) *The Roughing Shop.*—In passing through the various sections of the steel works at Cornigliano, as we have passed through them, the visitor has assisted at the gradual development of a gun or plate of armour. He has seen the English, Swedish, or Elban iron melted. He has observed the adding of the scrap, the dosing with nickel and chromium, and, finally, the tapping. At the long process of cooling in the ingot mould, however, the honour of his absence has been courteously requested, since it is one of the subjects on which the firm prefers to withhold details till further experience over a wider variety of products confirms the good results which are stated to have been lately obtained by Professore Federico Giolitti, the director. For the present it can only be said that the system followed is that of controlling the rate of cooling by means of electric currents induced in the mass of metal under the action of coils carrying an alternating current of very high frequency. The ingot, having cooled, has been lifted from the mould by the 200-ton crane—if it be an ingot for a 15in. gun—and has been trimmed, reheated, and forged. It will now be bored and rough-turned on the lathe at Cornigliano. The annealing operation will come next, and afterwards the tempering by reheating to 750 deg. Cent., then plunging rapidly into the oil bath at 18 deg. Cent., and leaving it to cool. Another annealing process then follows at 480 deg. Cent., and the part is allowed to cool in the furnace, after which samples are taken of its metal. Should these prove satisfactory, it is ready to be finished at Sampierdarena.

In the case of armour plate of ordinary thickness two or more forgings are usually necessary, and are naturally preceded by reheatings. The former operation occupies 1½ hours, and the latter from 8 to 10 hours. The plate has now assumed its rough shape, a margin of ¾in. to 2in. (20 mm. to 50 mm.) being left for planing, according as to whether it is to be curved or straight. It is then trimmed by the oxy-acetylene flame. The apparatus in the roughing

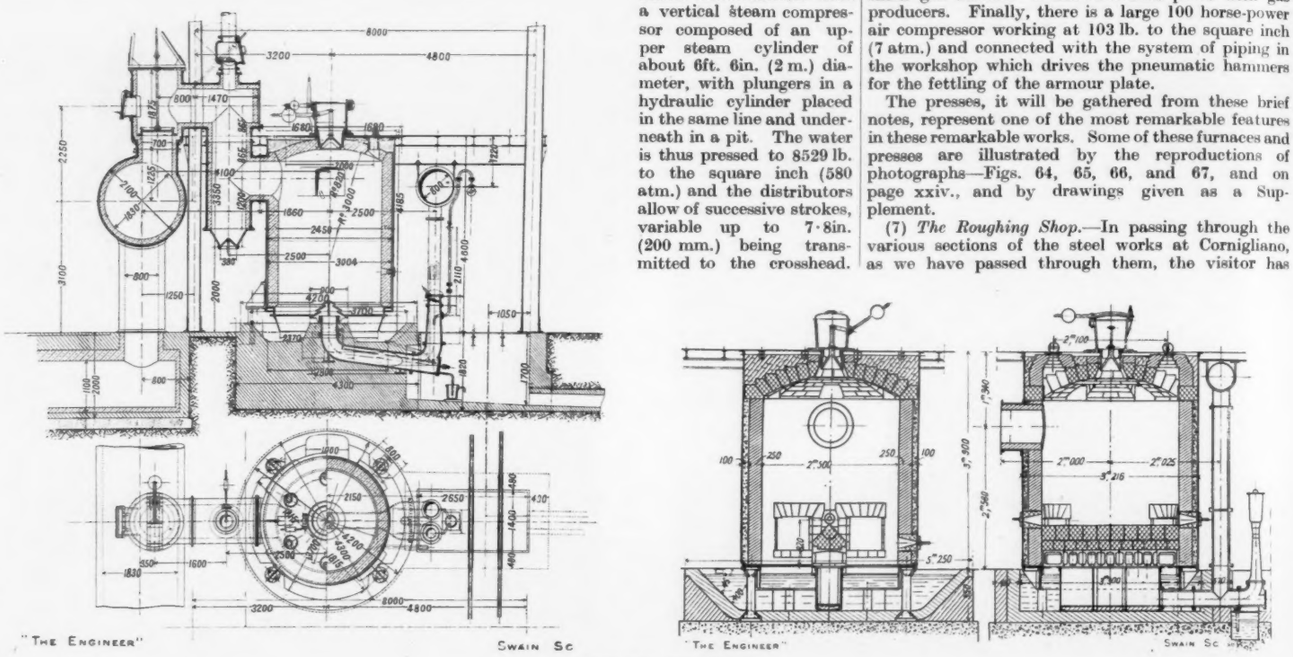



Fig. 63—STEIN GAS PRODUCERS

This system, however—for metallurgical reasons—is hardly ever used. The steam is generated by a central battery of Steinmuller water-tube boilers and liquid fuel Ansaldo boilers, as being the most adapted to irregular and sudden demands. These boilers can all work independently and are linked up in parallel, thus forming a central station capable of producing about 48,502 lb. (22,000 kilos.) of steam, or 57,320 lb. (26,000 kilos.) under forced draught per hour. The feed water is pumped up from the subsoil to a water tower and filtered. A noteworthy particular is the low pressure—44 lb. to 59 lb. per square inch (3 to 4 atm.)—at which the high-pressure cylinder fills with water before the tup comes into contact with the piece. This arrangement results in a considerable gain in efficiency.

The ingots are heated in two large gas furnaces with bottoms of 29ft. 6in. by 13ft. 1in. and 16ft. 5in. by 9ft. 10in. (9 m. by 4 m. and 5 m. by 3 m.) dimensions moving on ball-race truck. The doors are 9ft. 10in. (3 m.) and 8ft. 2in. (2·50 m.) high respectively. The furnaces are on the return flame regenerating principle, with regenerators placed immediately under the furnaces, and each one is made to be able to serve any of the presses. One furnace, however, with movable bottom of 42ft. 7in. by 13ft. 1in. (13 m. by 4 m.) is without regenerator, and serves for the reheating of armour plate at a low temperature for the 10,000-ton and 15,000-ton presses. The flame, in heating, is made to follow the line of the furnace roof up to the opposite wall of the furnace, so as not to strike directly on the pieces.

The generators are linked to each other by overhead and underground conduits, so that the continual production of the gas necessary is ensured in any case of cleaning or repairs. They are of the air blast type with central and circumferential inlets and a water tank underneath. Each generator is fitted with a steam blower as a stand-by against emergencies.

Fig. 65—FURNACES FOR PRESSES

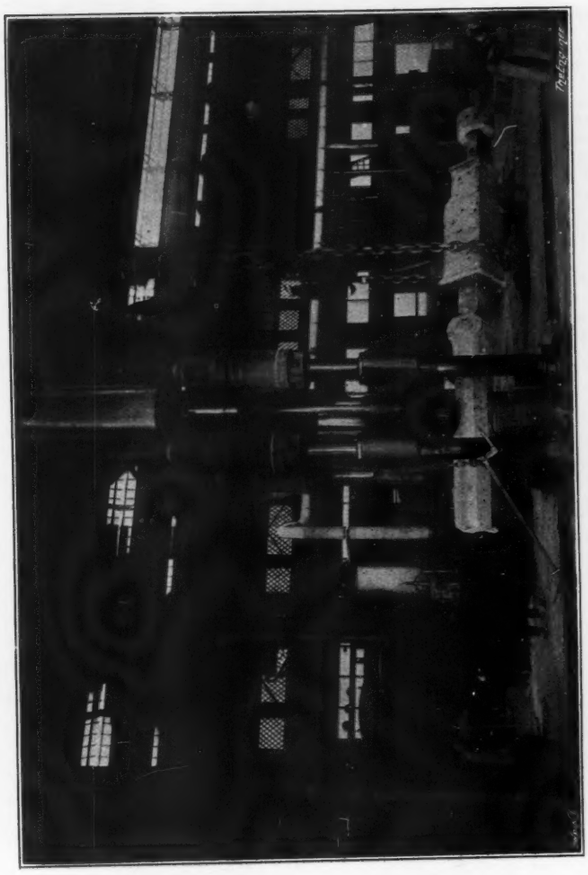


Fig. 67—FORGING UNDER PRESS

Fig. 64—FURNACES FOR PRESSES

Fig. 66—10,000-TON FORGING PRESS

department can cut lengths of 23ft. (7 m.) to a depth of 15¾in. (400 mm.) at a speed varying according to the percentage of carbon, but which is normally 2in. (50 mm.) per minute. After this, and before going through the thermal treatment, the plate is rough machined and bent.

The roughing shops—see Fig. 48, G, H, I, and Figs. 70 and 71, p. xxii.—are built parallel to the section for thermal treatment, and consist at present of six bays, each 492ft. long by 79ft. broad (150 m. by 24 m.), and covering a total area of 74,271 square feet (6900 square metres). The plant contained in this shop is, as indeed all through Ansaldo's works, of a potency superior to that necessary for the requirements of to-day. It is as complete and effective for high output as any existing in Europe.

The first bay (G) is given up to six planers for armour plate, with tables 14.7ft. (4.50 m.) between the columns. The height to the cross-slide is 6.5ft. (2 m.), and the stroke 26.2ft. (8 m.). Each of these planing machines has five tool carriers, and can take a plate of the largest dimensions known.

The next section (H) contains three pit planers, oil engine plant is now being constructed of 1500 to 1600 horse-power.

The system of railway lines, as well as the cranes, are both admirably devised.

(8) *Thermal Treatment Department.*—We have now arrived within the precincts of the *sanctum sanctorum* of Ansaldo's new works. The space devoted to the plant is an unusually large one, even for Cornigliano, where everything is on a liberal scale. The section consists in four great bays, 525ft. (160 m.) long, with a total breadth of about 300ft. (90 m.). The shop is a continuation of the last department, where are the hammers and presses. There is, in fact, no visible division between the two, and the facility of communication and interchange of cranes is of no slight advantage to rapid production.

The most prominent part of the plant is a battery of eight gas furnaces—see drawing on page xxi.—with movable bottoms, 42ft. 7in. by 13ft. 1in. (13 m. by 4 m.), for tempering and hardening. Of these, four are on the continuous regenerator system, two on the reversing regenerator principle, and the remaining two are non-regenerative. All have electric mechanism for

A jet-cooling plant—Fig. 72 page xxii.—modified by Ansaldos' to suit their requirements, and having a movable trolley with working surface of 26.2ft. by 13.1ft. (8 m. by 4 m.), is placed near the furnaces. The plate to be tempered is introduced horizontally between two groups of perforated pipes, which play water on to the upper and lower surfaces at a high pressure variable within wide limits. A battery of four centrifugal pumps, direct coupled to 2000 horse-power electric motors, draw the water from a reservoir of 70,629 cubic feet (2000 cubic metres) and send it into the piping, which also conducts it back again to the place whence it came when it has finished its duties of tempering the plate. There is therefore but little waste.

At the head of the shop is a vertical gas furnace—see Figs. 68 and 69—72ft. (22 m.) high, and an oil well, 82ft. (25 m.) deep, served by a travelling crane 98ft. (30 m.) high, driven by electricity, and lifting 45 tons. With this plant the longest tubes of 12in. (305 mm.) or 15in. (381 mm.) guns can be heated and plunged in oil.

The process used in the Ansaldo steel works for

Fig. 68—TEMPERING FURNACE AND OIL WELL

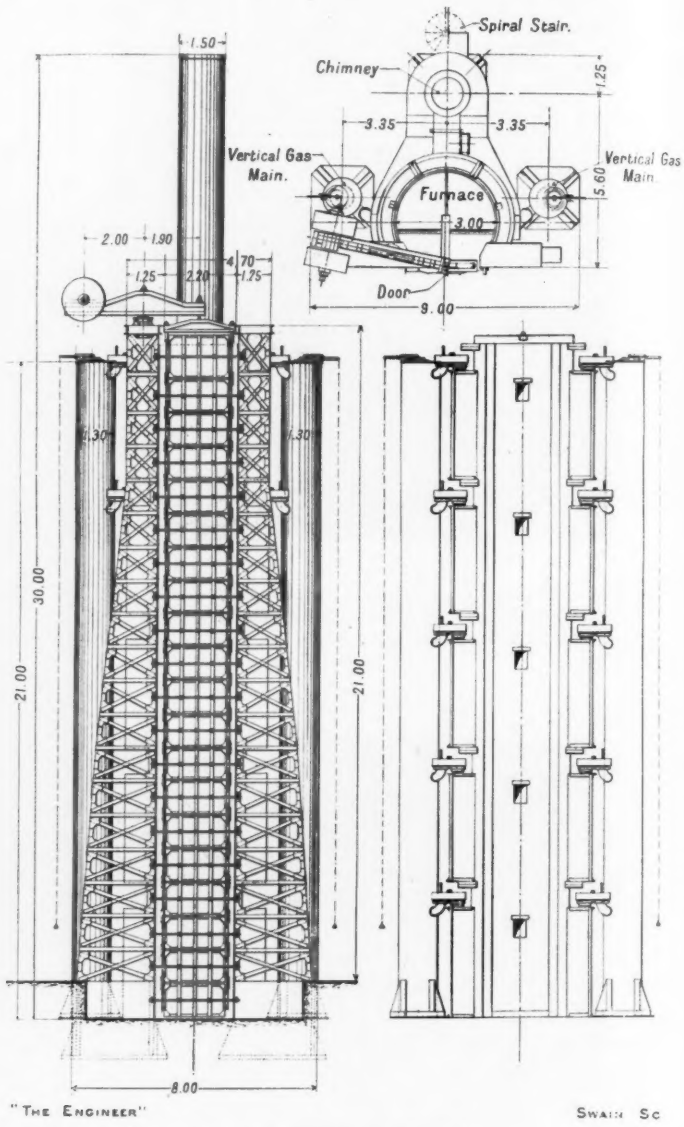



Fig. 69—GUN TEMPERING FURNACE

32.8ft. (10 m.) long, and with a movable cross-slide 15.7ft. (4.80 m.) broad, and 32.8ft. (10 m.) stroke, for the machining of plates, however bent they be. The pit is 13ft. (4 m.) deep, and is provided with powerful chucks and clamps for holding down and adjusting the position of the bent plates. There are also two lathes of 82ft. (25 m.) effective length between centres, double boring machines of 105ft. (32 m.) and 144ft. (44 m.) long for the machining of the inner tubes of guns, a battery of universal milling machines, a series of universal vertical drills for drilling and tapping holes up to 4¾in. (120 mm.), a circular saw of 6.5ft. (2 m.) diameter, and 19.6ft. (6 m.) stroke, the oxy-acetylene apparatus already mentioned, and a series of powerful grinders.

In the last section (I) are the less heavy tools and those for the roughing of the smaller guns.

Except in the case of the small tools, there is a separate electric motor for each machine. The energy utilised is 4400 horse-power, and it is distributed in three-phase alternating or in continuous current, according as to whether the motors have a constant number of revolutions or a variable number and automatic reversing gear. A steam group of about 450 horse-power is always ready as a stand-by, and also a crude oil installation of 600 to 700 horse-power coupled to a three-phase alternator. A second

the opening of the doors and for pulling the trolley in and out, and all are built so as to take the largest sizes of armour plate likely to be made for some time to come. The trolleys can be drawn out through the back as well as through the front to facilitate the operations of charging and discharging into and from the furnace—see plan, page xxi. The bays where the furnaces are charged and where they are unloaded are both served by electric travelling cranes, specially arranged for the rapid movements essential to the tempering process. They can lift 80 tons, and have a span of 59ft. (18 m.). An overhead conduit of 9ft. 8in. (3 m.) diameter puts them into communication with the underground conduit outside. Cut-off valves and chambers allow of the isolation of each separate furnace and of the regulation of the gas from the gas producers.

Four other smaller gas furnaces, of 29ft. 6in. by 13ft. 1in. (9 m. by 4 m.) dimensions, serve for the reheating and tempering of the armour plates, and are sufficient for the maximum production of the works given the remarkable rapidity of the hardening process. The carbonic acid necessary for this latter operation is distributed to the various ovens by piping, and is furnished by a central station in bottles which contain it at a pressure of 1764 lb. per square inch. A large mill provides the granulated charcoal.

the making of armour plate is held to be the most sacred among the sacred mysteries, and its priests are chosen for their capacity of expressive looks and more expressive silence. Even the foreman's cat is of a different mould to the less responsible cats of the pig iron foundry. It has a self-contained air of grim diffidence and answers, when addressed, only in monosyllables. The fact is that the armour plate making operation as practised here is, as far as we can learn, essentially diverse in several respects from the systems adopted by other makers. We are informed that differential tempering of every sort is done away with, and the tenacity of the back part of the armour is obtained by taking advantage of the marked degree of thermal hysteresis which characterises the steel used. It is therefore thought advisable to withhold details, at any rate for the present. Generally speaking, it may be said that the ingots are rough machined and then completely forged under the press only. The plates, which are solid and never compound, then undergo the cementation process, which is similar in its broad lines to that already touched upon in the beginning of Chapter II. This lasts between six and seven days, and is immediately followed by the various phases of thermal treatment.

The advantages claimed are those of rapidity in

## GROUP OF FURNACES IN THE STEEL WORKS

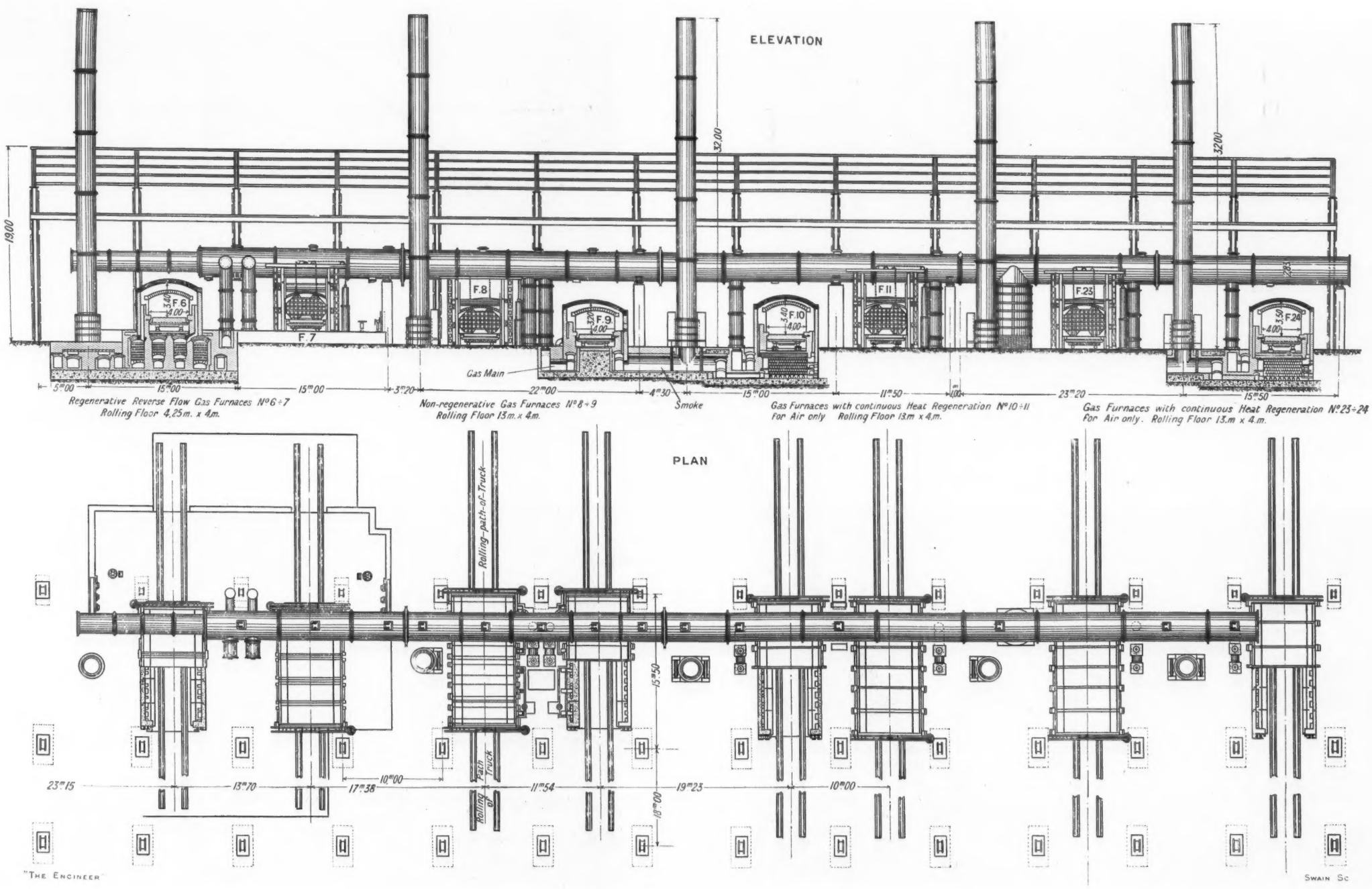


Fig. 70—ROUGH MACHINING FORGINGS

Fig. 71—ARMOUR-PLATE PLANING MACHINES

Fig. 72—ARMOUR-PLATE SPRAYING BATH

Fig. 73—FURNACE FOR THERMAL TREATMENT

manufacture, of the elimination of the various troubles caused by the use of differential tempering, and of the certainty of obtaining a maximum and well-defined concentration of carbon in the cemented stratum without risking general brittleness or surface cracks. Furthermore, there is the benefit of being able to cement the plates after the bending process, and of avoiding thereby the damage to the cemented surface which is almost inevitable when the curving takes place after hardening.

During the various phases of cementation and thermal treatment the temperature of the furnaces is accurately controlled by electric and optical pyrometers, which are calibrated in their turn against standard pyrometers set by taking fixed points of fusion. The electric pyrometers are all coupled up to a central office.

A rough idea of some of the results obtained by Professore Federico Giolitti's method may be formed

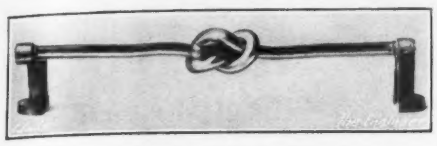


Fig. 74—DOUBLE KNOT IN MILD STEEL

from a glance at the following tables, in which two lots of test pieces taken from the same steel for guns—Ni 2 per cent.—are compared. The first have been treated by the ordinary process, the second by the new one of which we are speaking. The bending tests are precisely identical in both cases, and are said to represent "the extreme limit possible for ordinary tempered and annealed steels." The mechanical tests are made from pieces taken transversely from the tubes.

TABLE A.—*Ordinary Treatment.*

| Diameter tube, internal. | Diameter tube, external. | Resistance per square m/m. | Elongation per cent. | Bending. |
|---|---|---|---|---|
| 210 | 340 | 67·2 | 21 | Cracked |
| 210 | 340 | 66·7 | 21 | Slightly cracked |
| 350 | 500 | 69·5 | 14 | Broken |
| 350 | 500 | 67 | 15 | Broken |
| 280 | 435 | 68·8 | 19 | Cracked |
| 280 | 435 | 71 | 18 | Cracked |
| 210 | 340 | 71·5 | 20 | Broken |
| 210 | 340 | 67·8 | 21 | Cracked |
| 280 | 435 | 66·5 | 21 | Slightly cracked |
| 280 | 435 | 66·7 | 20 | Cracked |
| 280 | 435 | 69·3 | 18 | Broken |
| 280 | 435 | 65·8 | 21 | Slightly cracked |

TABLE B.—*Special Treatment.*

| Diameter tube, internal. | Diameter tube, external. | Resistance per square m/m. | Elongation per cent. | Bending. |
|---|---|---|---|---|
| 210 | 340 | 68·5 | 26 | Sound |
| 210 | 340 | 70·3 | 25 | ,, |
| 280 | 435 | 72·4 | 23 | ,, |
| 280 | 435 | 76·1 | 22 | ,, |
| 350 | 500 | 71·6 | 24 | ,, |
| 350 | 500 | 73·7 | 21 | ,, |
| 350 | 500 | 67·4 | 25 | ,, |
| 350 | 500 | 69·2 | 24 | ,, |
| 280 | 435 | 73·7 | 22 | ,, |
| 280 | 435 | 75·2 | 20 | ,, |
| 280 | 435 | 74·2 | 21 | ,, |
| 280 | 435 | 72·7 | 23 | ,, |

With regard to steel castings, it is claimed that the drawbacks which render practically impossible their thermal treatment in the ordinary manner do not show themselves in this process, which imparts to them mechanical properties absolutely on a par with those of the best forged steels.

It is, in short, to be hoped in the interests of science that Professore Federico Giolitti may gratify before long the expectation of his many admirers,

Fig. 75—SINGLE KNOT IN MILD STEEL

and may give to the world the results of his researches to mark a fresh era in metallurgy and to add new lustre to a name already famous in Italian modern history.

(9) *Projectiles.*—The making of projectiles is another subject which must be sketched on the widest lines. The process followed is that of M. Paul Girod. The steel ingots, obtained with the Girod electric furnace already mentioned, are heated to the right temperature for rough forging under the 1500-ton press. They are then reheated again, and finished with the 10-ton hammer, after which they are ready for the processes of rough machining, boring, tempering, finishing, tapping, re-tempering and polishing. The workshop where these operations take place is by the side of the department for the rough machining of the gun parts, and is divided into two bays. The first measures 128ft. by 33ft. (39 m. by 10 m.), and contains the necessary furnaces for case-hardening, together with the tanks for the first and the final temperings. In the second, 187ft. long by 33ft. broad (57 m. by 10 m.), are the machine tools for centering, turning, rectifying, making of the caps and putting on of the driving bands. The shops are served by travelling electric cranes of from 5 to 10 tons lifting power, and of a specially rapid type.

(10) *Rolling Mills.*—These are now in commission, and will be shortly set up on the plot of ground—see Fig. 48 O—parallel to the gas producers of the furnaces for the thermal treatment of armour plate. They are destined specially for the making of plates of from ¾in. to 4in. (20 mm. to 100 mm.) thick for locomotive and naval work.

## CHAPTER IV.—SESTRI PONENTE.

(1) *The Shipyard.*—The Sestri Ponente shipyard—Fig. 76—as it is now, takes a high place as regards size, length of sea front, number and size of launching ways, and producing power of plant. It occupies an area of 1,033,337 square feet (96,000 square metres), of which 318,612 square feet (29,600 square metres) are covered by buildings, and may be roughly divided, for the sake of clearness, into the eastern and western sections.

The eastern section, which is complete in itself, represents a modernised form of the old yard originally built by Giovanni Ansaldo, and, though provided with all the necessary plant for the construction of vessels even of considerable size, is used chiefly for torpedo boats. Enlargements, however, are now being undertaken, and further plant to the value of about £40,000 has been ordered. At present it has two blacksmiths' shops of 40,903 square feet (3800 square metres), and a third of 22,604 square feet (2100 square metres) kept at the disposal of Sampierdarena for the making and setting up of piping on board the ships under construction. There is also a building where the compressed air appliances for the pneumatic tools are housed, a cabinet makers' shop of 13,562 square feet (1260 square metres), a shed of 28,524 square feet (2650 square metres) for building small torpedo boats under cover, two masonry slips of 492ft. and 426ft. in length (150 m. and 130 m.), as well as the necessary open spaces and sheds for wood and the storing of ways, shores, submerged ways, and other such bulky paraphernalia required for the operation of launching. Special mention should also be made of the appliance for the galvanising of sheets for the hulls, since it is one of the largest in the world. It consists in three tanks. The largest measures 28ft. by 4ft. 3in. (8.50 m. by 1.30 m.), and contains no less than 80 tons of zinc, for the melting of which there is a special coal furnace. Two smaller units for pickling and the necessary registering pyrometers complete the plant, which is enclosed in a shop of 5382 square feet (500 square metres), served by two electric cranes worked from a fixed cabin.

The western, or new, section is also independent, and is given up to the building of large vessels. The platers' shop, composed of three great bays, with an area of 69,965 square feet (6500 square metres), contains a machine for bending plates up to 2in. (50 mm.), two edge planers for thick plates, a complete hydraulic plant with presses for stamping manholes, a compressed air apparatus of 500 horse-power for the working of the pneumatic tools, shears with a cut 6ft. 6in. long (2 m.) for plates of various thicknesses, a great flanging machine, a press for bending keel plates, two heating furnaces, and an infinity of other implements.

This shop serves four large slips in masonry for the building of vessels of 984ft., 820ft. and 656ft. long—two slips—(300 m., 250 m. and 200 m.), which for want of space have been carried over the Genoa–Ventimiglia line on bridges of iron and armoured concrete. They are called, from the names of some of the principal ships laid down on them, the "Bersagliere," the "Giulio Cesare"—ex "Lombardia"—and the "Garibaldi" slips respectively, the first-named being the largest and capable of still further prolongation by another 164ft. (50 m.), or to a total length of 1148ft. (350 m.). Two other permanent slipways are at the disposal of smaller craft, and ten temporary wooden ones can also be set up.

Three electric shipbuilding slewing tower cranes are at the service of each of the principal slipways. They vary in heights from 96ft. 5in. to 197ft. and 262ft. (29.40 m. to 60 m. and 80 m.), and have a radius of 115ft. (35 m.), with a lifting power of 6 tons. They were designed and built by the firm, which has constructed them with the suspension bolt fixed and the female part turning upon it on a ball race. The swinging or slewing mechanism is similar to the training gear of the naval gun turrets which we have already noticed in describing the mechanical section at Cornigliano as being one of the specialities of the firm. The cranes can therefore be regulated to a great nicety.

The principal slips are further served by three complete shops for the working of the various kinds of material. Each of these is independent and administers solely to the needs of the slip to which it is attached, thereby obviating all danger of confusion. There are fifty electric cranes here, and about 150 machine tools, the greater proportion of which are of English manufacture. Two pumping plants of 300 horse-power, which can be coupled in parallel, are set apart for the driving of the hydraulic machines, and act at a water pressure of 1470 lb. per square inch (100 atm.). The furnaces are fired by coal or liquid fuel. The motive agent is electricity throughout the works, with the exception of the steam for the hammers. The power is derived, as at Sampierdarena and Cornigliano, from the Società Negri in both alternating and continuous current, but a stand-by is provided in the shape of a private steam central station of 600 horse-power.

The electric repairing and tool shops, together with the sailmakers', photographers', draughtsmen's, and modellers' sections cannot be more than barely mentioned, for lack of space. The last named are, however, particularly interesting, occupying as they do 15,500 square feet (1440 square metres) on the first storey of the director's offices, and containing, besides the library of drawings, a complete collection of beautifully finished models of the principal ships built by the firm.

The well-thought-out scheme of organisation, as exemplified by the fitting shops attached to each building slip, does not stop with that particular. It is evident everywhere. The various open spaces, workshops, and slips which compose the two sections of the yard at Sestri Ponente are united by a network of lines which in their turn communicate with the railway. From this latter the material is carried directly to the stores, and from them to the various shops and to the ship under construction. This transit is rendered as short as possible, useless journeys to and fro are avoided, and it may be said broadly that the material which enters at one extremity of the works leaves it in the form of a completely rigged ship at the other end, after having pursued its journey always in the same direction without having been obliged to retrace its steps during the phases through which it has passed. Its progress towards completion runs parallel with its progression towards the vessel for which it is destined.

(2) *Launching on the Ligurian Coast.*—Few of those who have experience of this difficult operation in England can realise how far more arduous it becomes when performed from the beach at Sestri. The problem of limited space is the only one which is absent from the calculation. There is a tideless sea to be reckoned with, an exposed coast, an inadequate depth of water, and an uneven and silting bottom. Added to these difficulties, the foreshore is public property. The slipway, both for the last few metres on land and also under water, cannot therefore be a permanent one, and has to be constructed without any solid foundation. The preparations are extemporaneous and, of necessity, hurried. The cradle is built with extra solidity, and the parts, continuous from end to end, are secured together and to the ship more rigidly than would be the case under other conditions. The hull is also reinforced internally, since the sea extremity, or breast, of the slipway is yielding. Up till now, however, the operations have been of that kind in which man "disposes"; beyond this point he can only "propose" and hope.

The temporary portion of the slipway is first laid down from the standing ways to the water, and is naturally liable to damage should a heavy sea set in. But the chief risk is met with in the ultimate stages of the preparations, for it is during this period that an ordinary swell from a southerly direction is enough to cause a postponement of the ceremony and heavy additional expenses. The submerged ways have first to be sunk to their place by filling with water the six compressed air caissons which flank them, and soundings have then to be made to ensure the fact that the slope of the ways on the bottom is of from 1 in 14 to 1 in 12, or identical with the inclination of the permanent slipway.

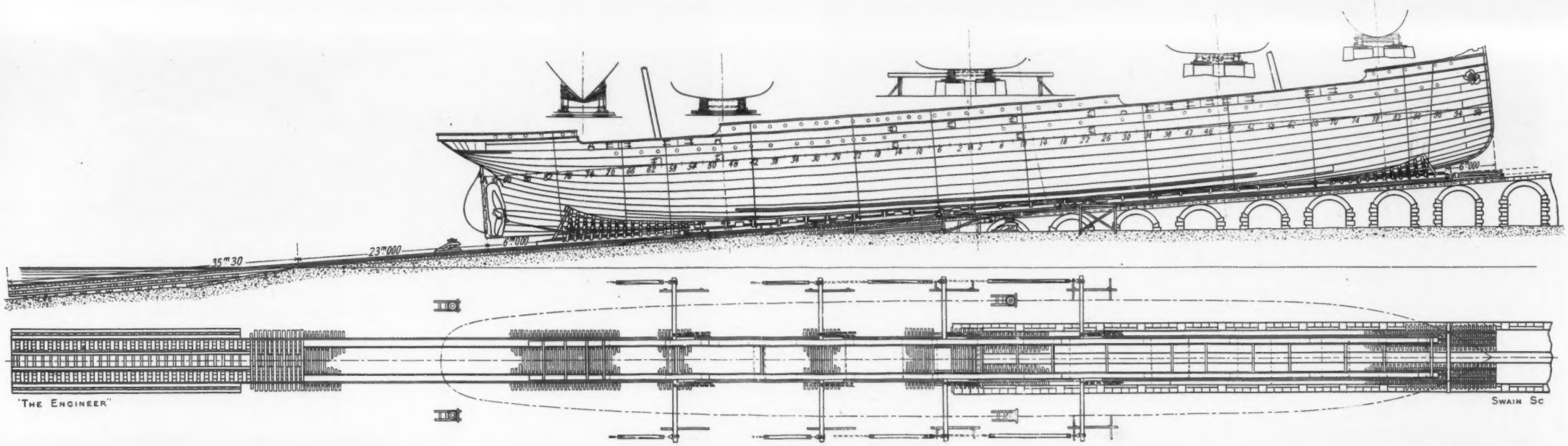
The final dredging operations, which are also put off till a few hours before the launch, especially if the weather is unsettled, have now to be completed. The shelve of the beach near the shore is about 1 in 10, and therefore sufficient for launching; but fifty yards out the bottom becomes nearly horizontal. This point marks the extreme limit of the submerged ways, and it is here that a deep hole is excavated with a channel leading from it of sufficient dimensions to ensure the vessel against touching the ground.

When all the preparations are ready the shores and blocks are knocked away and the ship remains held on each side by a number of strong oak levers—see drawing of the launching gear for a typical vessel on page xxv.—to the free ends of which are fastened purchases secured to the ground. Picked men with axes, of the famous craft of the Ligurian *maestri d'ascia*, are stationed by each of these ties, and electric bells communicate to the stations from the raised platform under the bows of the vessel. The godmother then breaks the traditional bottle and immediately presses a button, which gives the signal. For a few moments the blows of the axes are the only sounds heard in the silence of the crowd, and then the ship glides off. In the remote contingency of her hanging the tackles are reversed and are used to force her down the ways.

The above method of launching, which is peculiar

10,000-TON HYDRAULIC FORGING PRESS BY BREUER AND SCHUMACHER

SYSTEM OF LAUNCHING AT SESTRI PONENTE




to Genoa, is now used for vessels of any size. Among the ships so dealt with at Ansaldo's may be mentioned the steamers Lombardia and Liguria, both of 400ft. long, and launched ready for sea with a weight of about 4500 tons, the cruiser Libia also launched all standing, the cruiser Garibaldi and the Giulio Cesare—see Supplement.

This battleship had a lauching weight of 8830 tons, and left the "Liguria" slipway on October 15th, 1911. No hemp lashings were used nor stops at the bows, but the simple method already described was resorted to. On each side six levers of 29ft. 6in. (9 m.) long were used, having a distance between fulcrum and power of 27ft. 9in. (8.50 m.). The launching cradle had a total length of 460ft. 7in. (140.40 m.), an extreme breadth of 27ft. 9in. (8.50 m.), and a sliding surface of 4598 square feet (4270.20 square metres). The bilge logs were made of four beams of Oregon pine 1ft. 3¾in. square (40 cm. by 40 cm.) lashed together with iron ties of 1¼in. (32 mm.) diameter and bolted to the oak bottom boards, which were 4in. (10 cm.) thick. Transom beams of 1ft. 3¾in. square (40 cm. by 40 cm.) were secured, at the distance of 2ft. 7½in. (80 cm.) one from another, on the bilge logs, and for the whole length of the launching cradle. Over these came 4in. (10 cm.) wedges of holm oak, and over these again the upper logs, the supports, &c.

The bow end of the launching cradle was built up of three distinct and separate parts. The first, 7ft. 9in. long (2.40 m.), consisted of transom beams and supports secured with transverse steel ties of 3 5/16in. (80 mm.) diameter. The other two were 11ft. 5in. and 14ft. 8in. long (3.50 m. and 4.50 m.) and were canoe-shaped. The three parts were separated by an empty space so as to allow a certain amount of flection to the launching cradle at the critical moment in which the stern of the ship begins to rise and the bow tends to press on the extreme forward portion of the cradle.

The space between this latter and the hull was filled up with a solid mass of wooden beams for the mere purpose of transmitting the load, the outside skin being in no way secured to the structure under it. The actual bearing part of the cradle was formed of steel sheets ¾in. to 1in. thick (20 mm. to 25 mm.), which were not, however, distributed symmetrically lengthways, but placed so that the greatest resistance should be concentrated in the fore end where the stress of rotation would occur. At this point three sheets, two of ¾in. and one of 1in., were laid one on another for a length of 4ft. (1.20 m.). It was therefore calculated that, if this part alone of the cradle were called upon to resist the reaction of the slipway, the material would in that moment be bearing a maximum load of 24,180 lb. per square inch (17 kilos. per square millimetre).

The submerged ways were made of several tiers of pitch pine beams of 13¾in. square (35 centimetres square) bolted firmly together. The supports formed a solid mass of wood. The weights were calculated to perfection and the vessel moved off spontaneously the instant the ties were cut.

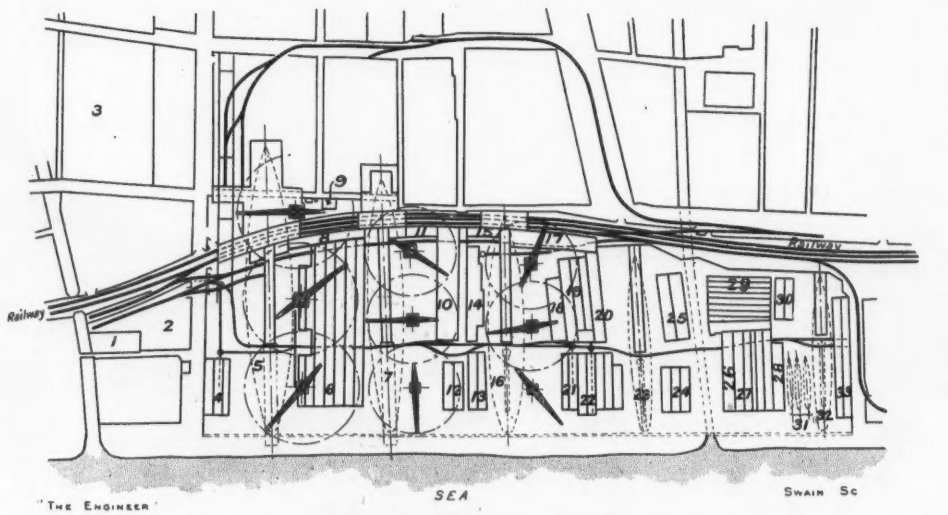



Fig. 76—SHIPYARD AT SESTRI PONENTE

1. Carpenters' Shop.
2. Carpenters' Store.
3. Unoccupied Land.
4. Smiths' Shop.
5. "Bersagliare" Slip for Ships up to 900ft. long.
6. Workshop for Small Parts for Slips 5 and 7.
7. "Guilio Cesare" Slip for Ships up to 820ft. long.
8. Angle Iron Smiths.
9. Electric Power Station.
10. Offices, Stores, and Drawing-offices.
11. Compressors, Model Makers, &c.
12. Riggers and Electric Repair Shops.
13. Drawing-office.
14. Electric Power Station, Repair Shops, Studios, &c.
15. Coal Stores.
16. "Garibaldi" Slip for Ships up to 700ft. long.
17. Tube and frame benders.
18. Furnace for angle irons.
19. Turners, patternmakers, sailmakers, &c.
20. Plate forges.
21. Drawing-office.
22. Cabinet Makers.
23. Slip for Ships up to 500ft. long.
24. Depot for Launching Ways and Submerged Ways.
25. Machine Shop.
26. Shed for Submerged Ways.
27. Torpedo Boat Shed.
28. Woodwork Connected with Launching.
29. Torpedo Boat Shop.
30. Galvanising Shop.
31. Small Slips.
32. Slip for Ships up to 420ft. long.
33. Store for Scaffolding, &c.

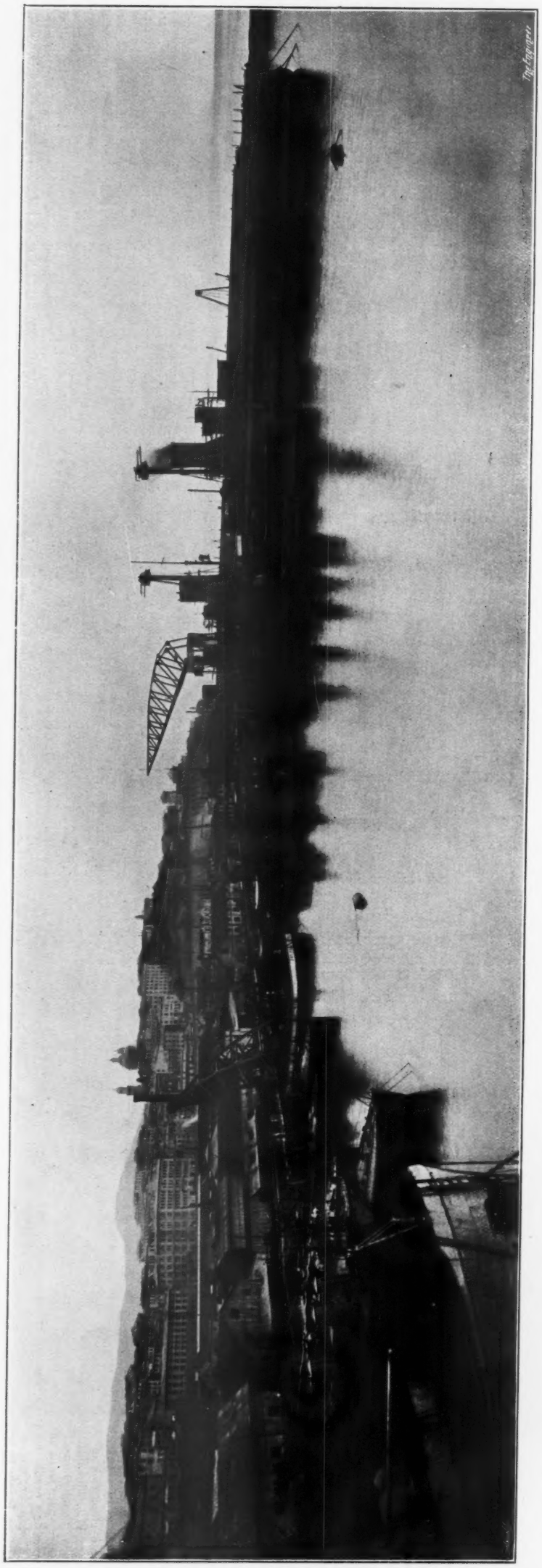
## CHAPTER V.—THE FITTING-OUT YARD IN GENOA HARBOUR.

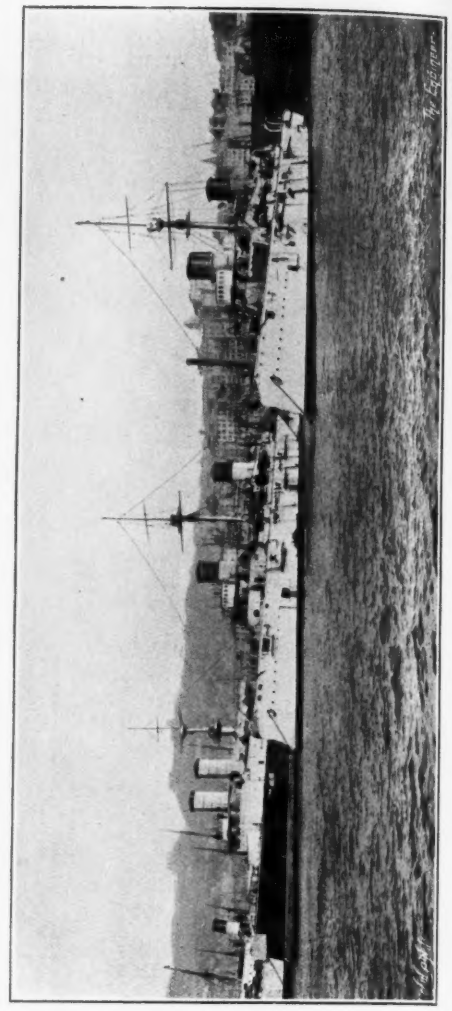
This is the natural complement of the shipyards at Sestri Ponente. The vessels for the mercantile marine, launched all standing, make this the base for their trials, while warships make a longer stay for the purpose of fitting out. Repairs to vessels of every type, as well as the fitting of battleships launched from the State dockyards, are also effected here.

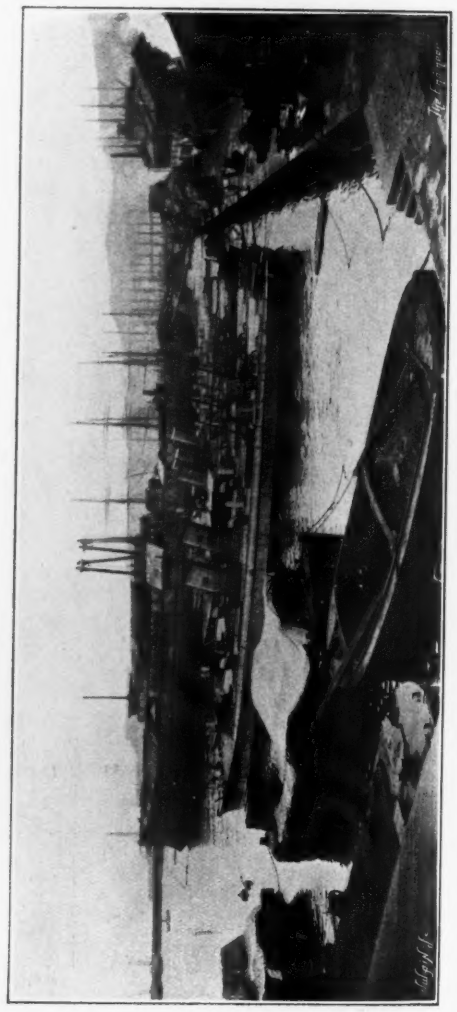
The works—see Fig. 77 p. xxvii.—are built on the pier which protects the docks. The sheet of water of 861,114 square feet (80,000 square metres) conceded to Ansaldo's is also completely sheltered from the south winds by the long jetty called the Molo Giano. The total area on land is 161,459 square feet (15,000 square metres), of which 80,729 square feet (7500 square metres) are covered by sheds and buildings several storeys high. The rest is made up of open spaces and wharves.

These latter are more than 2296ft. (700 m.) long, and have fixed and slewing cranes for handling the goods as well as sheds for their reception. Traffic conditions on them would, however, be rendered

VIEWS OF THE FITTING OUT BASIN IN GENOA HARBOUR







congested in the extreme if it were not for an ingenious system of raised ways crossing over the wharves and connecting the works with the ships being fitted out. The additional crowding caused by the hundreds of workmen and tons of material which pass to and fro between the vessels and the shore is thereby eliminated.

The shops are larger and more completely provided than might be thought necessary by some for works having their headquarters so near as Sampierdarena; but the system of independent centres which, here as elsewhere, is the keynote of Ansaldo's organisation conduces automatically to rapidity of output. The machine tool section at the Molo Giano, as also the blacksmiths', carpenters' and cabinetmakers' shops, together with the finishing department, are all on a scale which permits them to do a considerable part of the heavy work without having recourse to outside assistance. There are besides the sections of the pipefitters, electricians and brassworkers, all of which have at their disposal a plant which may be qualified in many cases as belonging almost to the category of a manufacturing establishment.

A large office divided into several departments distributes the tools for the working of the metal or wood, keeps up and repairs the pneumatic and electric appliances, and constructs the special apparatus for the rectification of the bolts to fix the armour on to the teak lining. It is also responsible for the drilling of holes in the plates and for the fixing of them to the battleship.

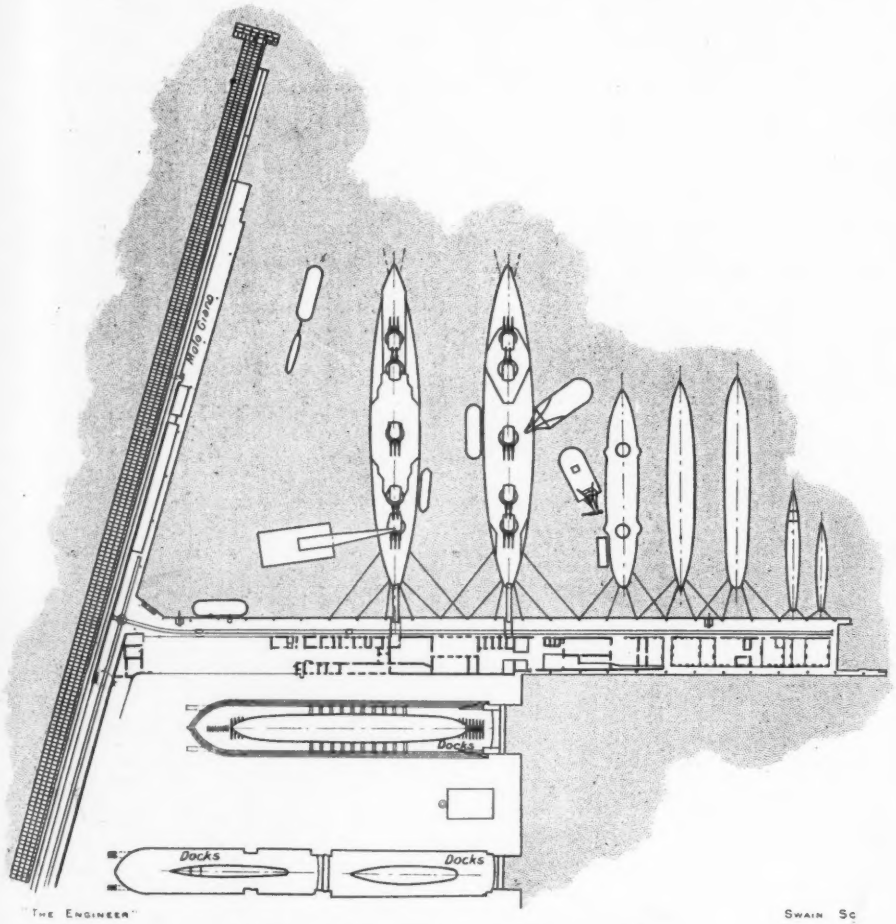



Fig. 77—PLAN OF FITTING-OUT BASIN AND WORKS

A pneumatic apparatus of 400 horse-power supplies the compressed air for the drills, riveters, hammers and chisels.

The electricity for power and lighting is drawn from the Società Negri at 12,000 volts by two 800 horse-power converters, but there is also a private steam electric plant of 300 horse-power which can be used as a stand-by.

The features, however, which most strike the visitor's eye are the floating cranes. Of these there are three of large dimensions. Two of them are worked by steam and are able to lift 60 tons and 120 tons respectively with fixed arm. The third is electric-driven, and has a height of about 230ft. (70 m.) and a slewing arm of 151ft. (46 m.). This great machine is one of the pivoting and derricking floating cranes, made by Smulders, of Schiedam, and can raise 150 tons without trouble. It is specially kept for the handling of heavy artillery, turbines, armour plate, funnels and high masts.

The works at the Molo Giano are now engaged in the fitting out of the Giulio Cesare and Duilio, as well as a considerable number of torpedo boats and ships for the mercantile marine. The number of hands employed is about 2000.

Views of the fitting-out basin and sheds are to be found on page xxvi.

## CHAPTER VI.—PALAZZO GAMBARO

*Labour, Wages, and Provident System.*—No student of Italian political economy can fail to notice the almost complete immunity from strikes enjoyed by Ansaldo's firm. In fourteen years we can count only six, all insignificant, of which four were imposed by professional agitators for extraneous reasons. In the other two, both among the riveters, the good sense of the men ended by regaining the upper hand.

The reasons for this satisfactory state of things are general as well as particular. The Ligurian masses dislike the introduction of outside elements. Genoese workshops are therefore manned by an overwhelming majority of Genoese workmen, contrary to the rule which holds good in Turin, and especially in Milan, where the worst strikes take place, and where the most turbulent units belong usually to the "cast-off contingent" of other provinces, and, indeed, of other nations. Genoese workmen—with the exception of certain closed corporations which do not come into our subject—are averse to adopting the arm of "the strike," which they consider unwieldy, expensive, and dangerous. They are, relatively speaking, content with their lot. Living at the fountain-head of Italian importation, they enjoy a financial status slightly more favourable than that of their inland brethren. Their families are on the spot, and these, whether represented by parents or children, act as incentives in the evening to allure the hands from the bar or meeting-house sacred to the rhetoric of workmen without work or of attorneys without clients. Family affection, sobriety, and hard-headedness are the salient virtues of the Genoese. The proportion of women workers, especially of married women, is smaller than in other districts, the number of places of amusement from the public-house to the picture palace is less than in other great cities, the willingness to work overtime is more apparent. In the second quarter of 1913 there were only nine strikes, with 2846 workmen concerned, in the whole of the province of Liguria, out of a total of 279 strikes made by 91,000 men in Italy, figures these, to which Lombardy alone contributed 58 with 56,900 bread-winners out of work.

Coming to the reasons for quiet in the firm of Gio. Ansaldo in particular, an impression should first be recorded as being that received by the visitor while passing through the various sections. It is the aspect of the men. They are bright, good mannered, and friendly. The stranger is not regarded as the natural enemy from the mere fact of his being probably an acquaintance of the master. Furthermore, if he talks to the hands, he will find that many of them have left, at some period of their lives, to work in other firms, but have returned again to Ansaldo's to stay there.

The favourable impression thus acquired is not dissipated by a conversation with Comm. Mario Perrone, the partner who has charge of the administrative side of the business in the frescoed rooms of the old Palazzo Gambaro standing in the historic street of palaces that has won for the city the name of "Genoa the Magnificent," *Genova la Superba*.

The time table represents the ordinary ten hours' day from 6.30 a.m. to 6 p.m., with an hour and a-half between 12 and 1.30 for lunch. The night shift is from 7 to 7. A study of the wages bill proves it to be a fair one, while every facility is given to the men of increasing their wages by accepting piecework. The system is old-fashioned and strikes a discordant note in an ultra-modern establishment; but it is understood by the men, who see in it their own advantage without a corresponding gain for their masters. Belief in the fact that the financial interests of the employed may go hand in hand with those of the employer is too much to ask, at present, even of the intelligence of the Ligurian workman.

It was, in fact, proposed to introduce an adaptation of the Taylor method, which had been thought out in order to eliminate the blot whereby, after the saving on the part of the workman of 50 per cent. of the time allowed, the standard of relative gain is lowered in such a ratio as to render the absolute advantage insufficient to stimulate him to further production.

The Ansaldo formula is as follows:—

$$\underset{(P)}{\text{Hourly premium}} = \underset{(W)}{\text{hourly wage}} \frac{\text{time saved } (t\,s)}{\text{time employed } (t\,e) + a \text{ time saved } (t\,s)},$$

or

$$P = W \frac{t\,s}{t\,e + a.\ t\,s}, \text{ here } t\,s + t\,e = \text{time allowed,}$$

and $a$ is a numerical coefficient to be calculated in each instance according to the nature of the work. By varying the value of $a$ the curve representing the relative gain of the workman is varied. This permits of a different standard being established between work requiring an intense mental or physical effort on the part of the performer and other work which merely needs attention and practice. The method is given here as being academically interesting. It has been held back for the present in Ansaldo's works, since it was wrongly interpreted by the men, who suspected a trap to diminish their gains instead of increasing them, as it actually does. The simple system of piecework possesses at any rate the advantage of inducing harmony between capital and labour at Ansaldo's to-day.

Let us pass on to the branch of philanthropic institutions. The firm has few private ones of its own, since they are rendered unnecessary by the multitudinous societies that exist in Sampierdarena. There is a technical library at the Molo Giano, to which the men have access. The hospital and first aid sections are well represented in each of the establishments, are amply found in the necessities of their office, and have male nurses in attendance day and night. The hands are all insured against accidents at a medium annual premium of 6s. 9d. (8.50 lire), while 2½ per cent. is taken from the yearly profits for the payment of old age pensions to those who are more than sixty-five and have been thirty years in the service. The fines exacted are paid into a Reserve Benefit Fund, for helping the men in exceptional circumstances, and the firm contributes a yearly quota equal to half the amount so kept back.

With the employees a somewhat similar method is practised. Each man leaves 5 per cent. of his stipend with the firm, which, on its side, credits his account with a like sum. At the end of twenty years he is at liberty to withdraw the amount thus accumulated with compound interest at 5 per cent. Should he leave, however, before that time he has a right to his own money increased by a twentieth part of the sum paid by the firm for each year he has been with it. Five per cent. interest is also allowed on all moneys deposited by dependants up to the total amount of the said dependant's stipend. Four per cent. is paid beyond such amount.

It is right to say that this system meets with the whole-hearted approval of the employees themselves. A policy of tact and wide views has, in short, made of Ansaldo's workshops an industrial centre which should be quoted among the first of Italy for quiet and cordial relations between employers, managers, and men.

## CHAPTER VII.—CONCLUSION.

Our visit is now ended. We have seen, shop by shop, the largest private enterprise in Italy. We have been impressed both by the quality of the work brought under our notice and by the appliances provided to the artificer for producing that work to the greatest perfection in the shortest space of time. We have admired both the purpose and its consummation, both the means and the end. But without doubt our considerations have not been of a material character alone.

The rapid enlargement of Ansaldo's works to their present proportions represents another step in the passage of Italy from the old order to the new; it denotes a fixed purpose in the minds of those who conceived the scheme to launch out towards an ampler horizon.

It is hard for an Englishman duly to value industry

under its national aspect; harder perhaps than it is for the members of other countries. The Englishman has found the way prepared for him by his ancestors. He is the *Civis Romanus* of the commercial world. Italy is, on the contrary, in the position of the *homo novus*. Entirely deprived of coal and but scarcely endowed with iron, she seemed destined to remain the pleasure ground, as she had once been the cock-pit, of Europe. Poets had sung of her as the land of love and music, and it was hard for her to doff the female garb and put on man's attire. The very idea that Italians are proving ardent workers in the world's field is still to many Englishmen a stumbling-block if it be not condemned as foolishness outright. But scepticism cannot exist in the face of facts; and those who have the palpable proof of those facts before them are also imbued with a deeper feeling of respect for Italian industrial pioneers from the knowledge of the difficulties against which they were pitted.

In such a category are to be reckoned men of the stamp of Cantoni of Castellanza, Alessandro Rossi of Schio, and Ansaldo of Sampierdarena. The hardest task fell to the latter, since the venture was based on the price of iron, which, though found in most European countries, might then be considered for practical purposes as non-existent here. Such a venture was therefore a well-nigh desperate one. Faith was needed of that sort which removes mountains. The same faith guided the brothers Bombrini, and the same is present now with Pio and Mario Perrone. They have faith in the "star of Italy," faith in themselves, faith in their workmen. The step they have taken is, again, that of a pioneer.

Italy in the metallurgical trades has been content as yet to aim at the gradual conquest of her own market, and little has been done beyond the limits of her frontiers; but the creation in three years of the new factors of production at Sampierdarena, Sestri, and Cornigliano cannot but indicate the fixed intention of entering definitely into the lists of international competition. This decision betokens in its turn confidence in the quality of the merchandise and in the limited cost of its manufacture. With regard to the former, the only unknown quantity to the outside world is the steel now being made for military purposes. This item, however, may be said to enter into the category of those rare units in which expense is a secondary consideration. Let us, therefore, pass to the long list of more ordinary merchandise in which the cost of production is of prime importance. Here we find ourselves face to face with the labour question in Italy, a question which presents itself at the present moment as of high interest to English and German manufacturers.

Seven or eight years ago the Italian craftsman was undoubtedly becoming a rival to be daily more respected. Speaking of the industry with which we are now dealing, he shows both advantages and drawbacks when compared to the Anglo-Saxon. He is far quicker in learning his work; he is minute in its execution. Against these virtues is to be put a lack of stability. The Italian hand is, in fact, more of an individual and less of a machine; as a result he bears less patiently the monotony entailed by the continued production of the self-same object. Specialisation is irksome to him; he aims at universality. The consequence is that the output of a complicated machine tool is in Italy less high than what it is in England. Taking, therefore, the price of the raw material as equal in both cases, the Italian master would be unable to compete if it were not for the lower scale of wages paid in his country.

It must not be thought, however, that the Italian workman is in reality less well off than his English colleague. His necessities are fewer; his standard of living is lower; and the same may be said with truth of all other classes of citizens up to the highest grades. Given this grand secret of success, combined with the natural genius of the Latin race, the Italian artificer —and for that reason the then rapidly rising Italian industries—threatened England and Germany a few years back with serious competition. The danger is diminished now, and the English manufacturer would be merely showing a decent sense of gratitude if he peopled the void of the Royal Exchange with the busts of Italian Socialists.

Italy has, to paraphrase a colloquial expression, "taken her Socialism badly," and the orgy is still proceeding. Whether the morning will bring wisdom or delirium tremens remains to be seen. The general rise in wages should be welcomed by the unprejudiced as long as margin is left to the producer. The evils engendered by the Socialist movement in Italy are rather the feeling of unrest, the jettisoning of all sense of duty, the confusion of liberty with licence, the blind hatred felt to the master as the workman's natural enemy. The outcome is the abandonment of discipline, unreasonable claims, equally unreasonable strikes at moments inopportune for the men themselves, and sometimes stupid damage perpetrated on the employer's property. Attempts to arrive at a higher rate of production are frustrated by the demagogues who pose as the men's advisers; the Weir, Halsey, or Taylor systems, or other such modern devices for the common benefit of employer and employed are discarded out of faith in the new gospel which proclaims the incompatability of the dual interests. The Italian workman, as an individual, is by far the most able in Europe; herded by the sheep-dog which he himself has chosen, his idiotcy on occasions approaches the sublime.

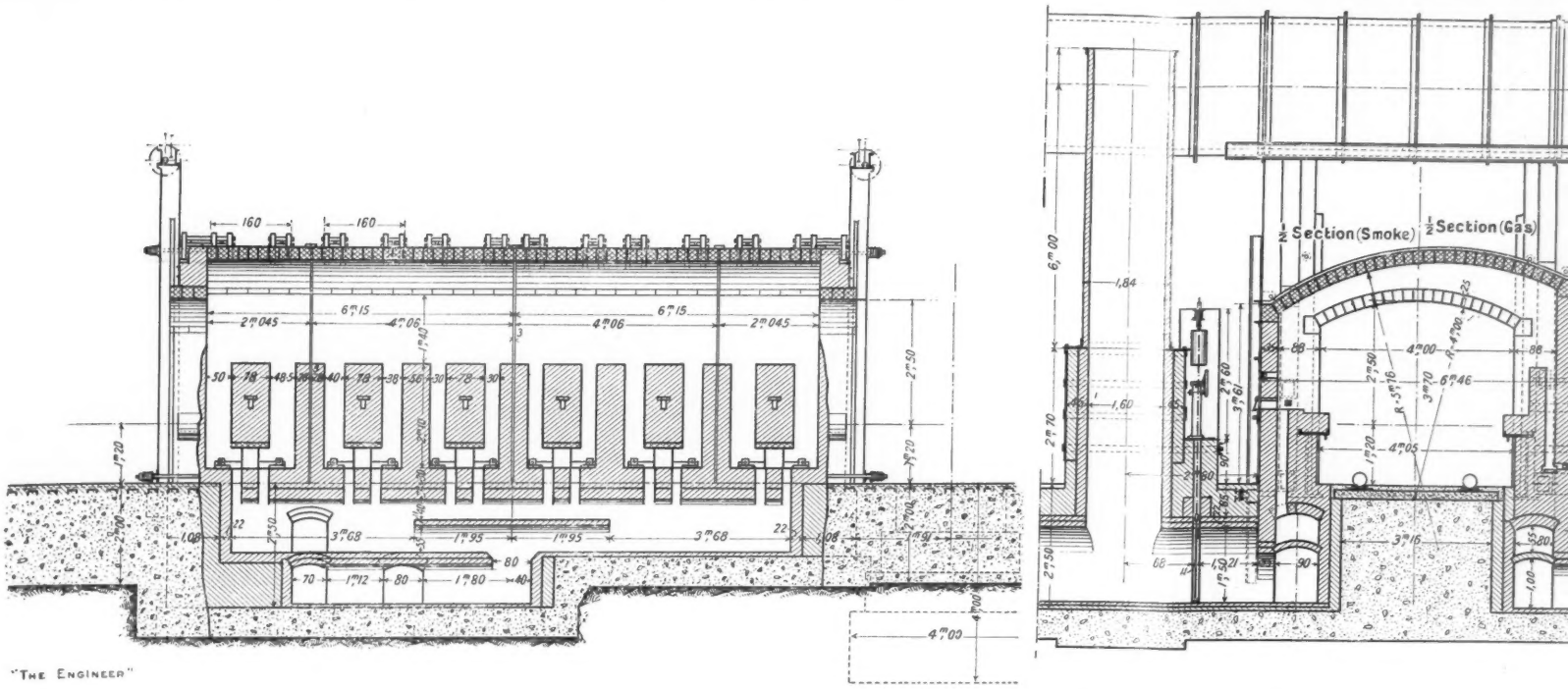
Under these circumstances the initiative of the brothers Perrone is the more courageous. Capital in Italy is shy at the present moment, not because it is scarce, but for many reasons of which the labour question is one of the most prominent, for it is argued that if the men abandon themselves to excesses when certain defeat is staring them in the face, strikes and loss of commerce may be looked on as of sure occurrence when the industrial crisis shall have again given place to a cycle of new prosperity.

In the particular case, however, the human material with which the Genoese firm has to deal is of a more balanced and generally superior type to what it is in many great shops, and the directors are probably not in error when they count on the proved good sense of their Ligurian workmen. Should their calculation be correct the firm will have to be seriously reckoned with in the future as a worthy international competitor.

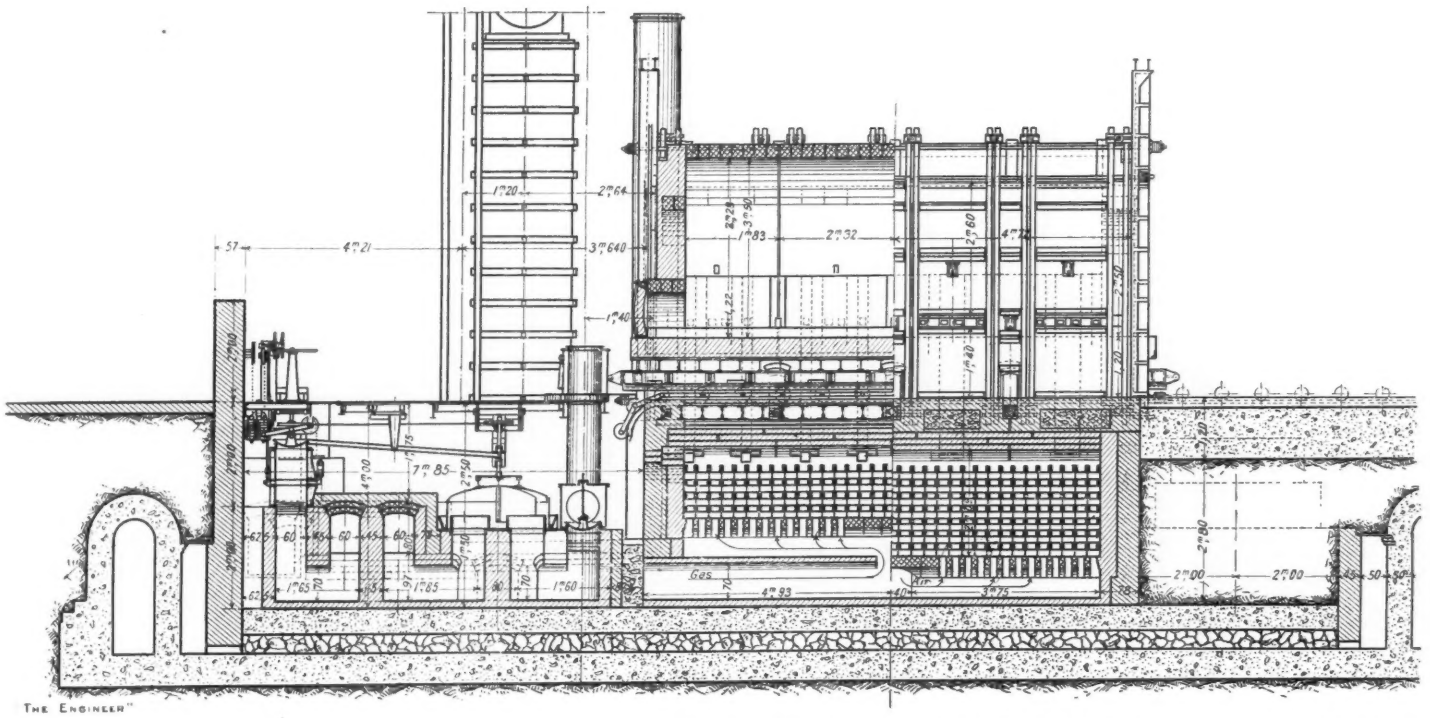
The gratitude of patriotic Italians is due in the meantime to Comm. Pio and Mario Perrone. The country is by their means fortified in her system of national defence. She is a stronger factor than before in the world's diplomacy; she is a stronger factor in the world's commerce.

In conclusion, I wish to express my warmest thanks for the help afforded me to Commendatore Pio Perrone, as well as to the directors, engineers, and foremen of the works, and especially to Comm. Antonio Omati, Director-General; to Col. Nabor Soliani, of the Naval Engineers, director of the shipyard; to Ing. Lodovico Pogliaghi; and once again to Ing. Camillo Manzitti, Vice-Director of the artillery section, without whose kind assistance this article would never have been brought to completion.

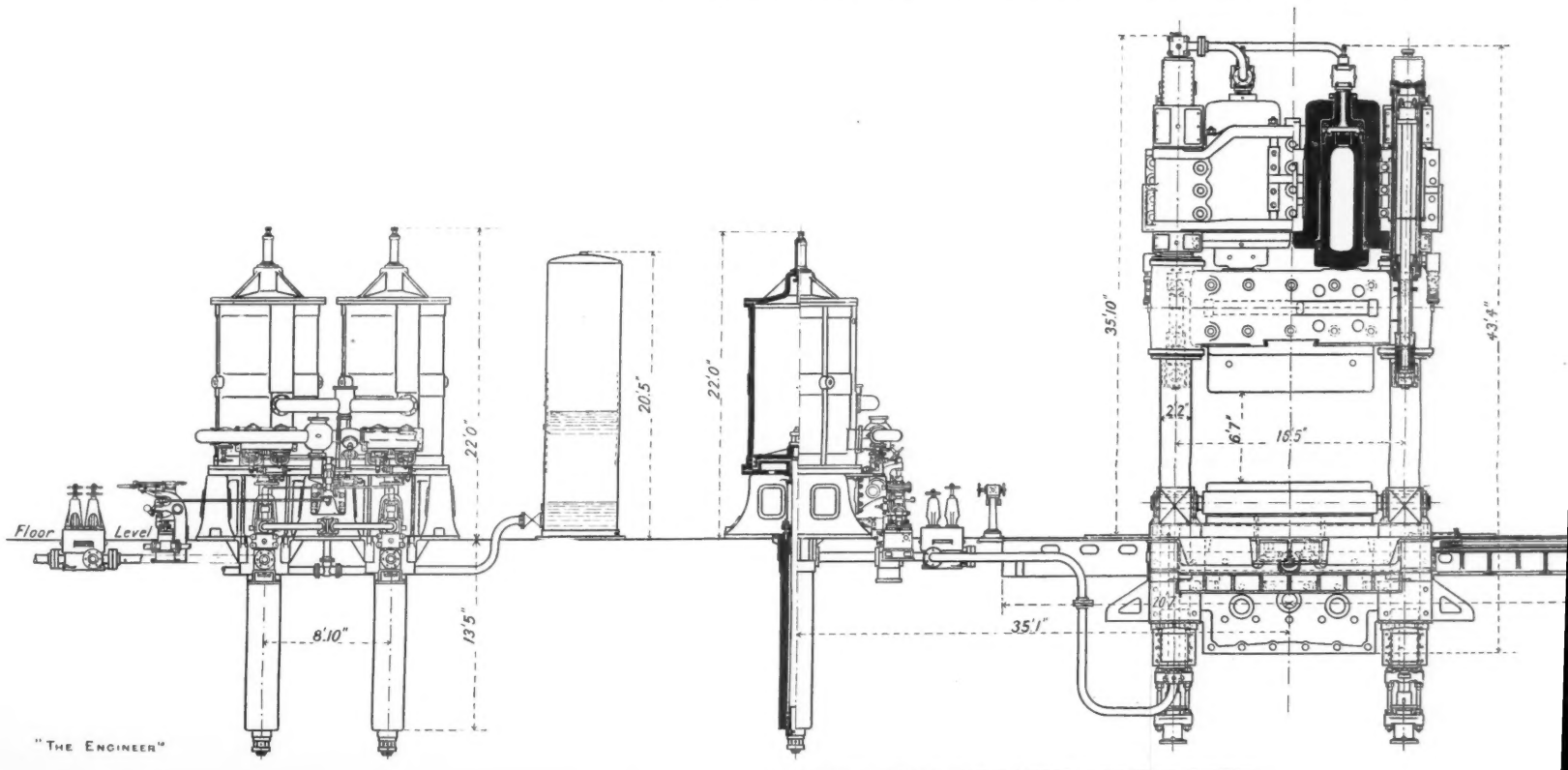
# FURNACES AND HYDRAULIC PRESSES AT GIO. ANSALDO




**STEIN HEATING FURNACE WITH MOVABLE FLOOR**

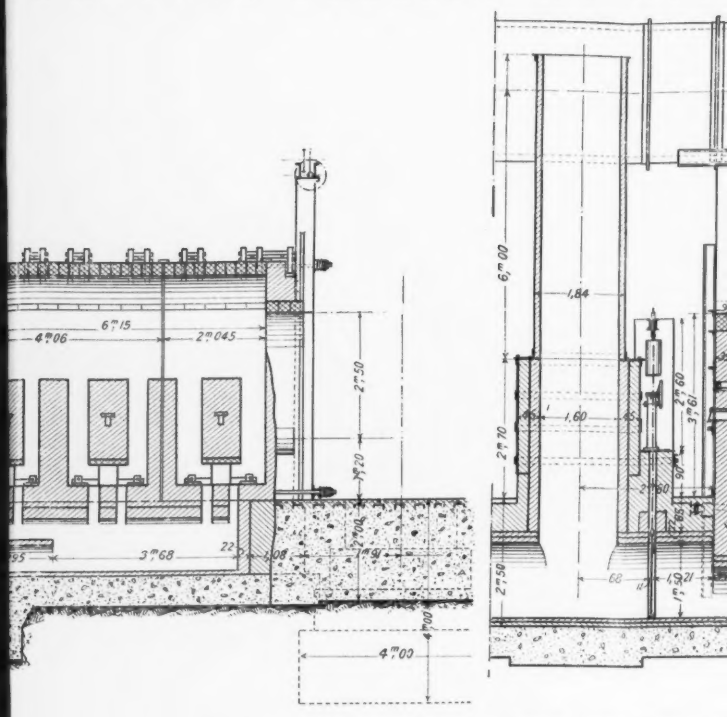



**STEIN REGENERATIVE HEATING FURNACE WITH MOVABLE FLOOR**

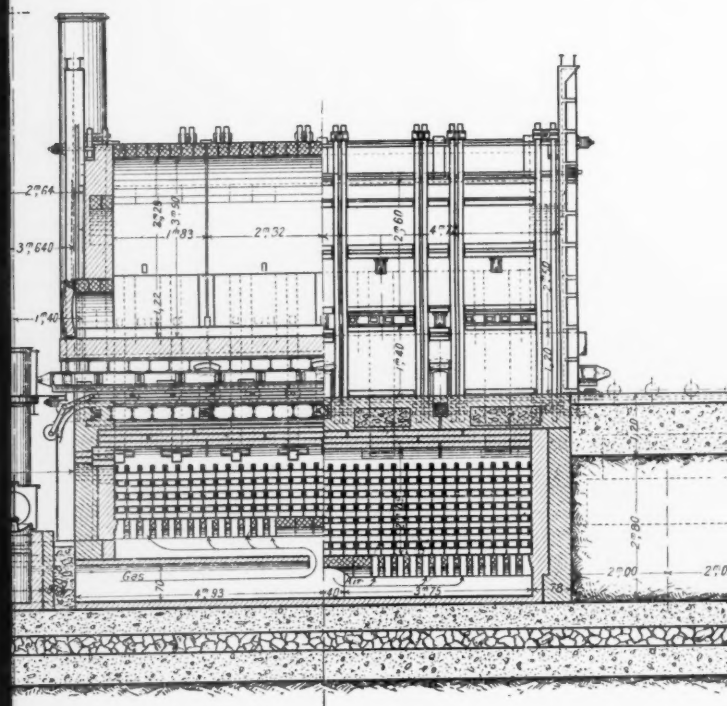



**10,000-TON STEAM HYDRAULIC FORGING PRESS**

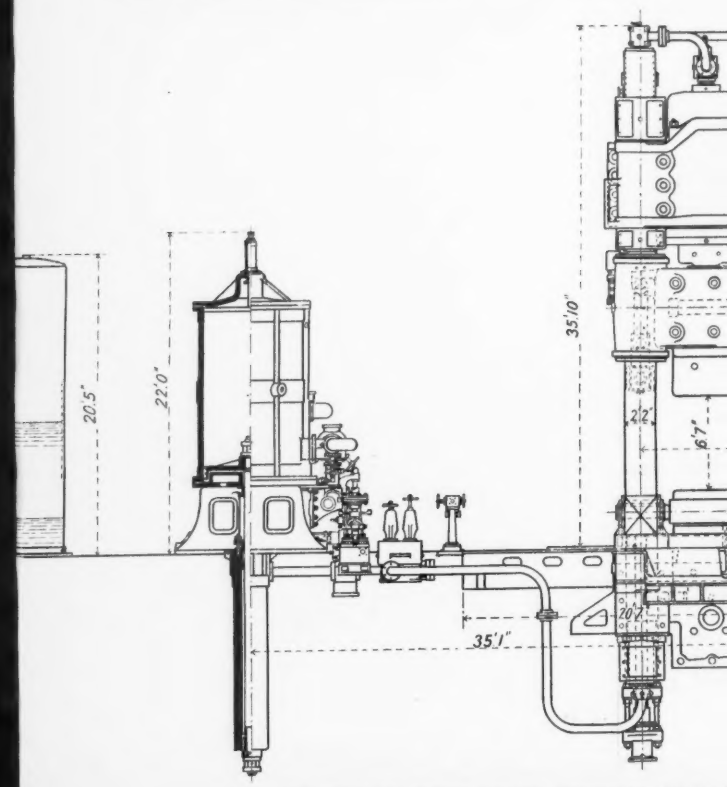
# YDRAULIC PRESSES AT GIO.




STEIN HEATING FURNACE WITH MOVABLE FL

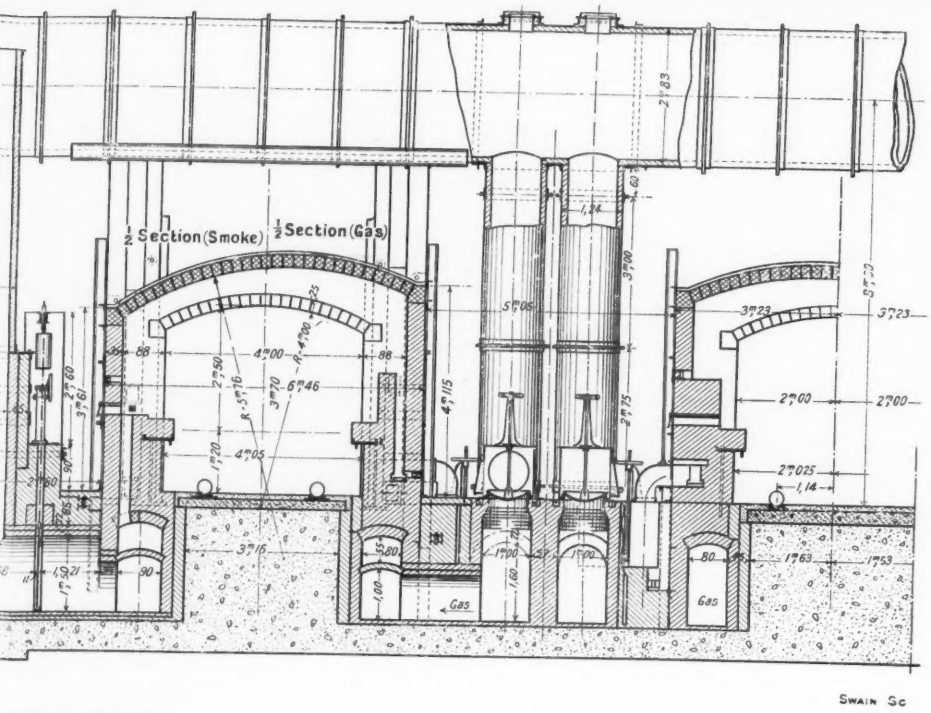



STEIN REGENERATIVE HEATING FURNACE WITH MOVA




10,000-TON STEAM HYDRAULIC FORGING PRESS

GIO. ANSALDO AND CO.'S WORKS

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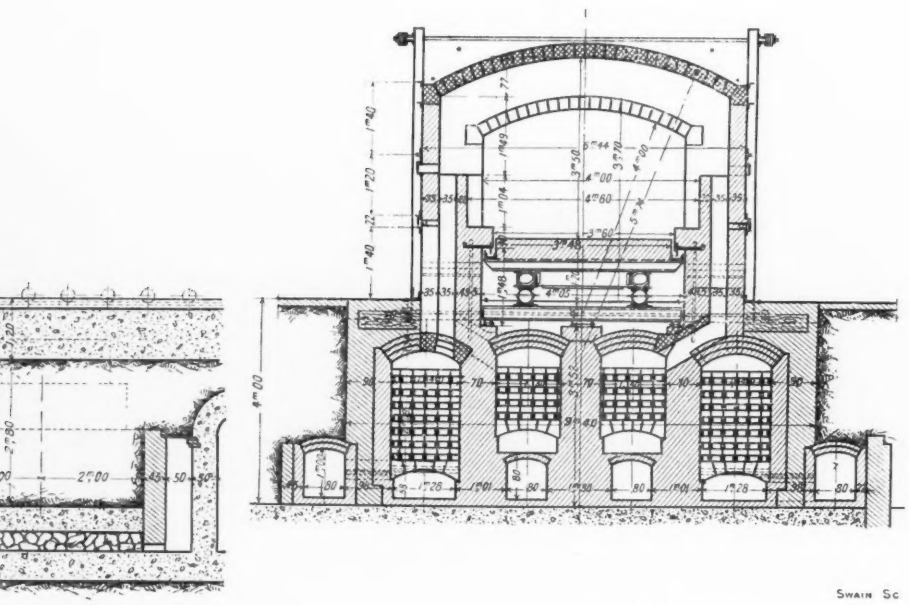
VABLE FLOOR



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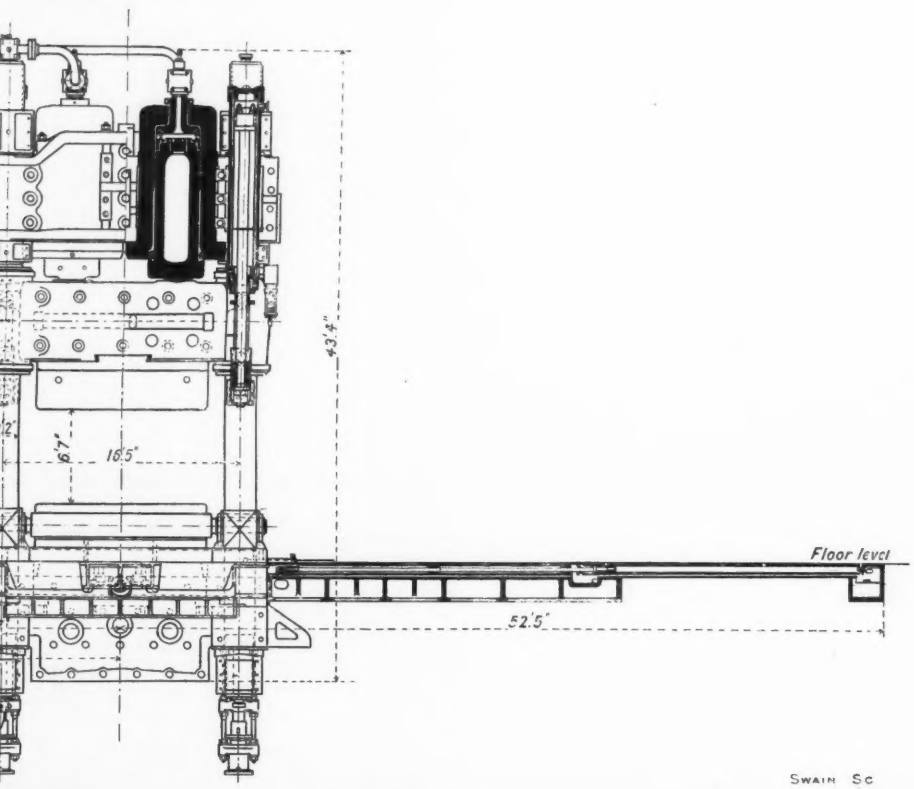
TH MOVABLE FLOOR

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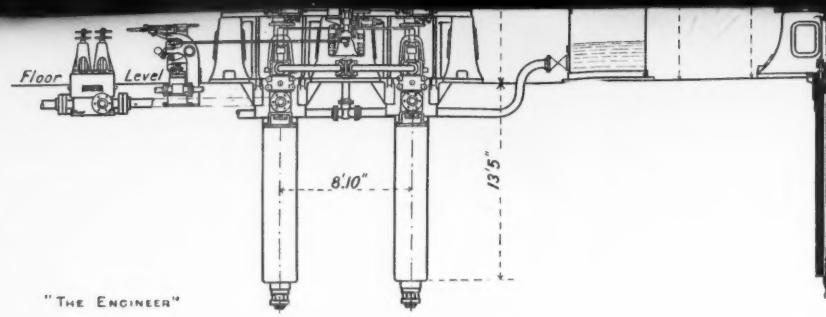
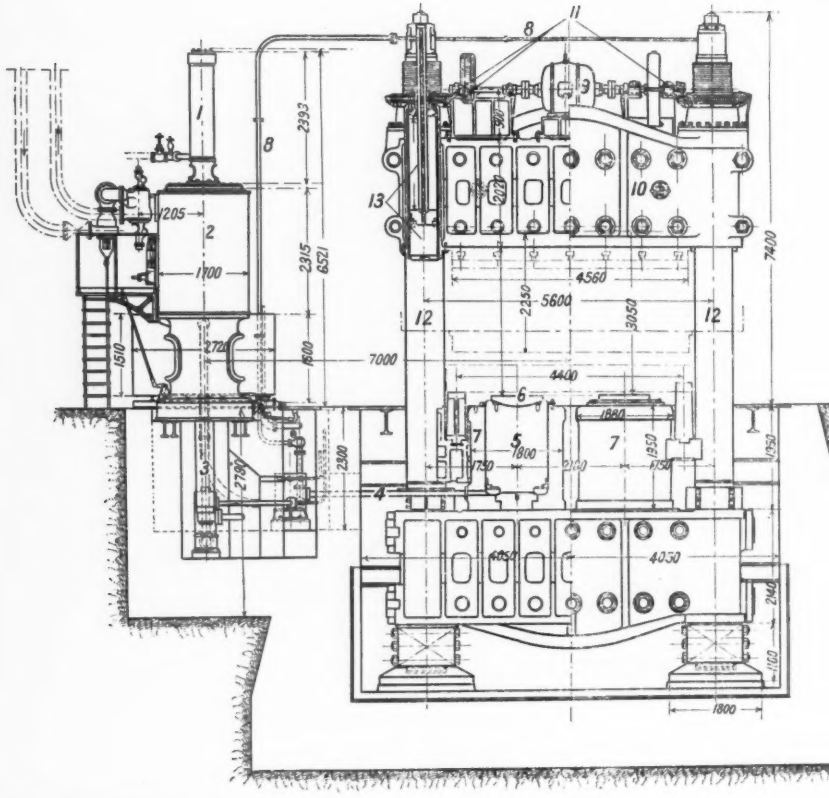



"THE ENGINEER"

10,0




"THE ENGINEER"

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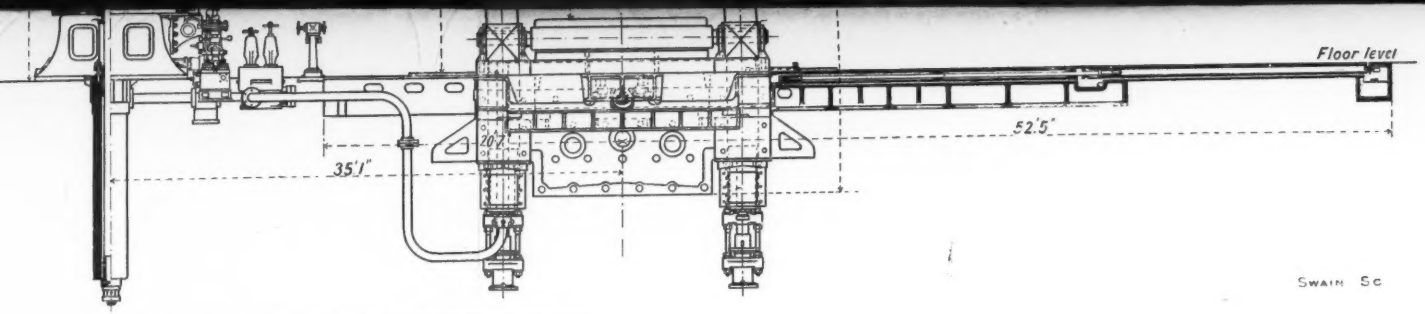
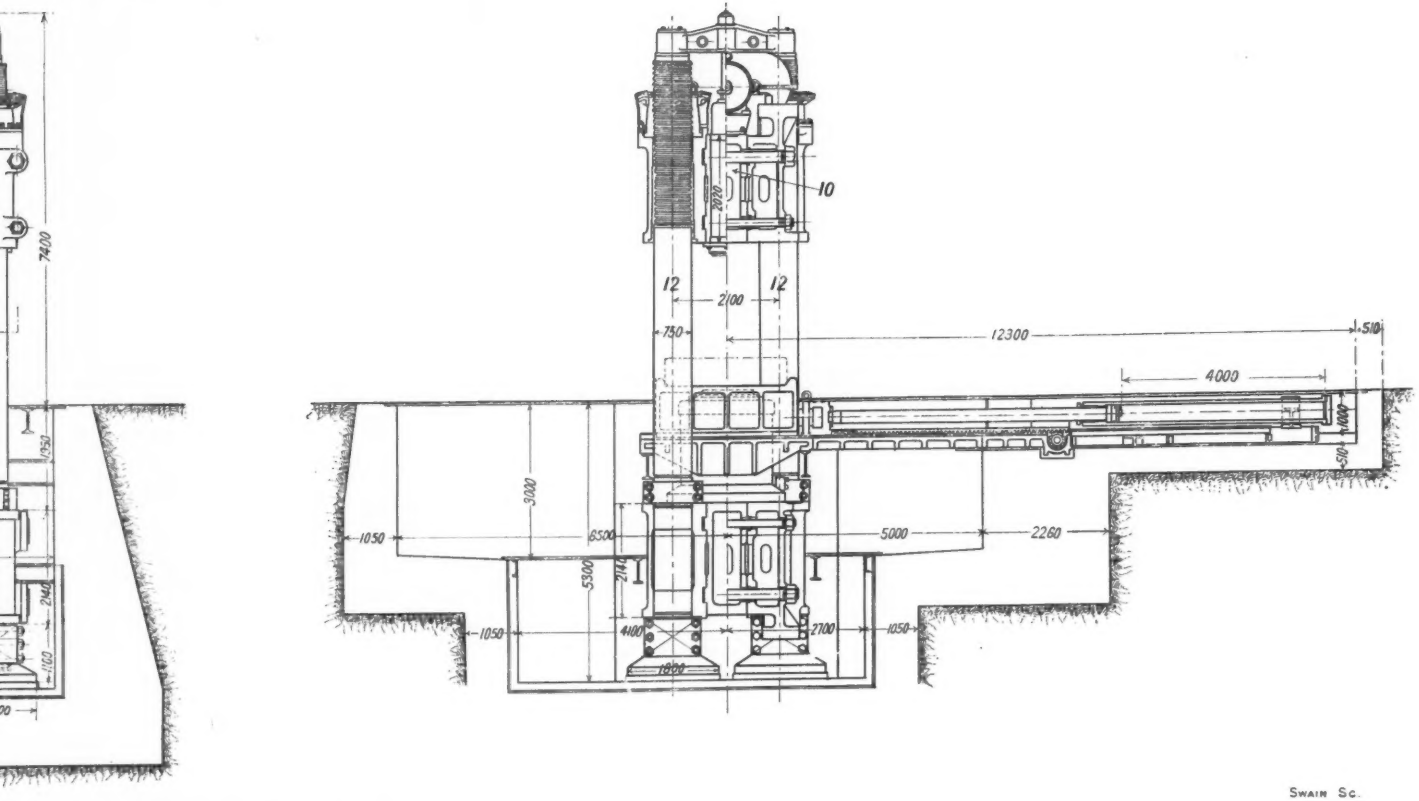



SWAIN Sc

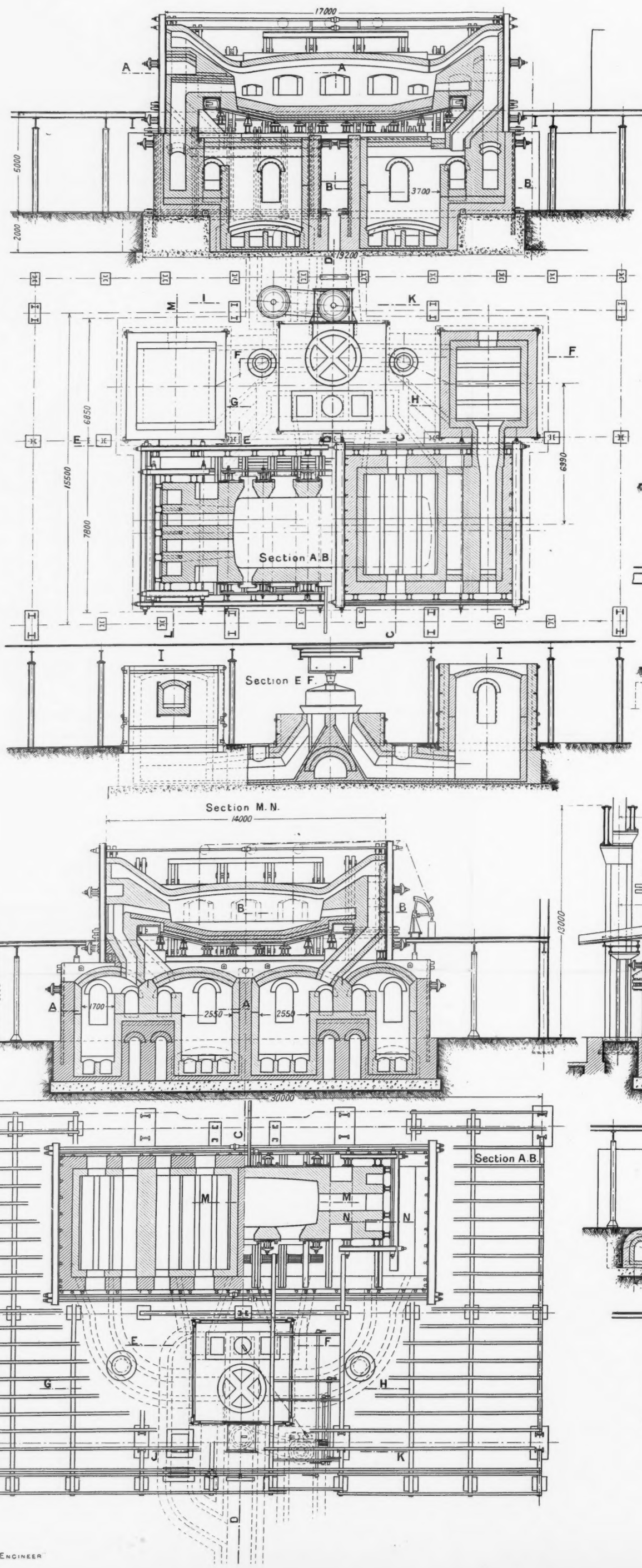
10,000-TON STEAM HYDRAULIC FORGING PRESS




SWAIN Sc.

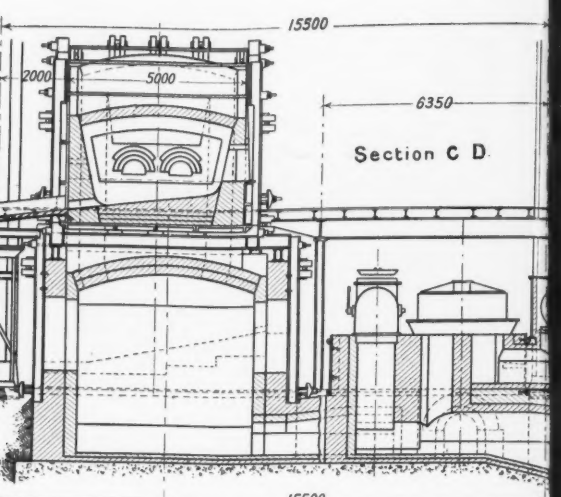
15,000-TON HYDRAULIC PRESS BY HANIEL AND LUEG

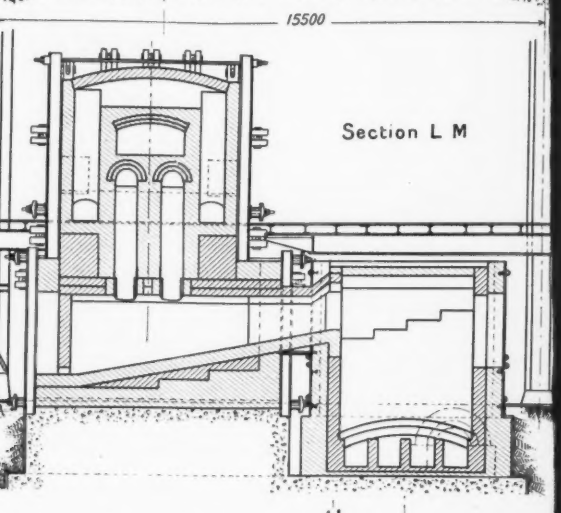
# SIEMENS MARTIN STEEL FURNACES AT GIO. ANS

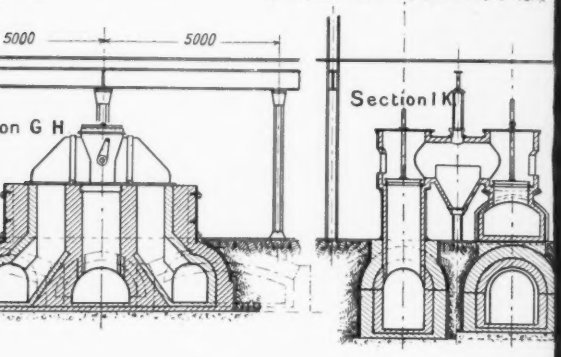


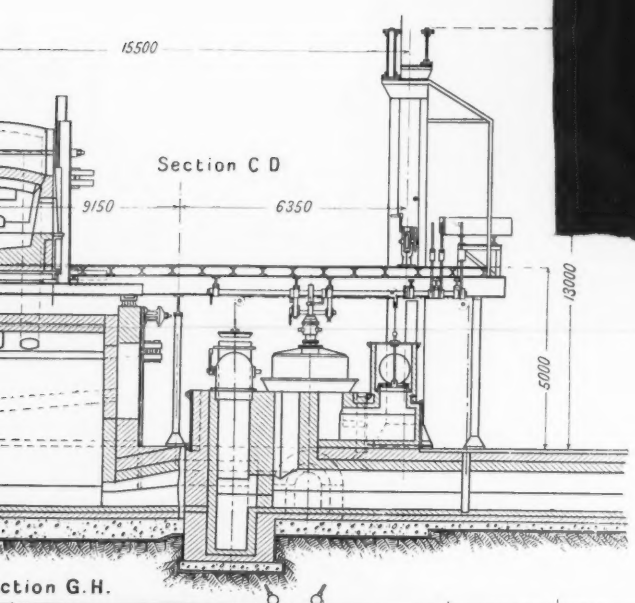

"THE ENGINEER"

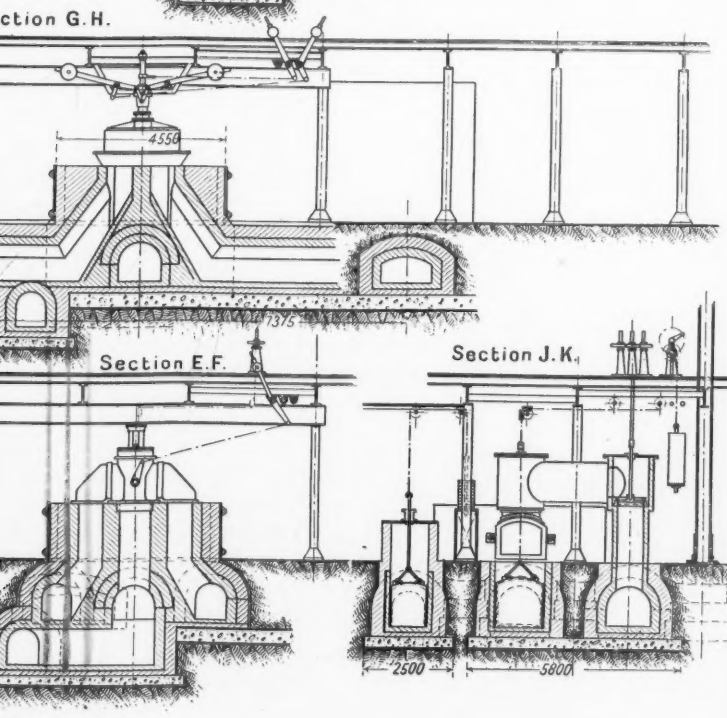
ANSALDO e CO.'S WO



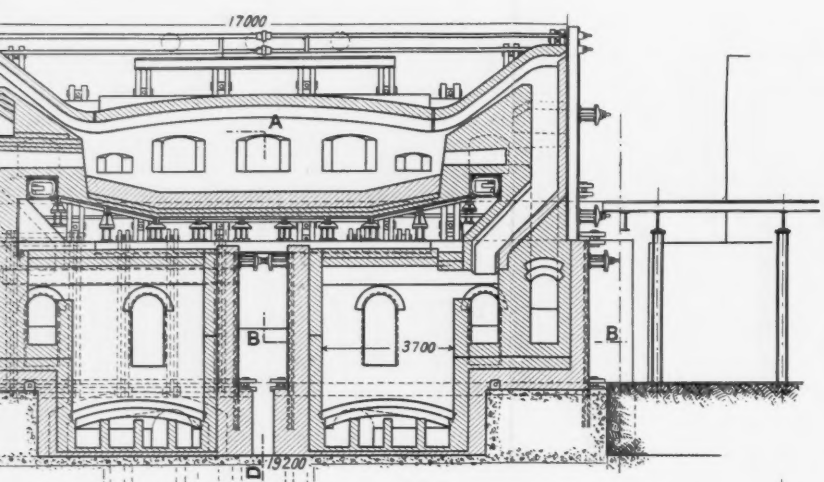



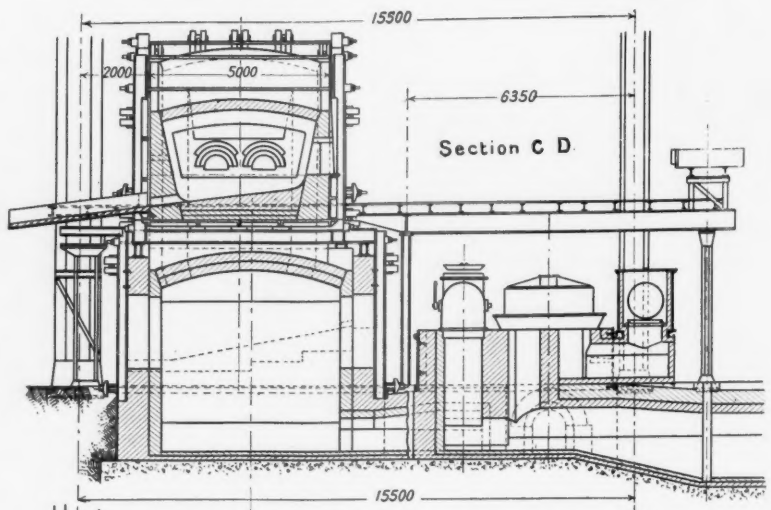



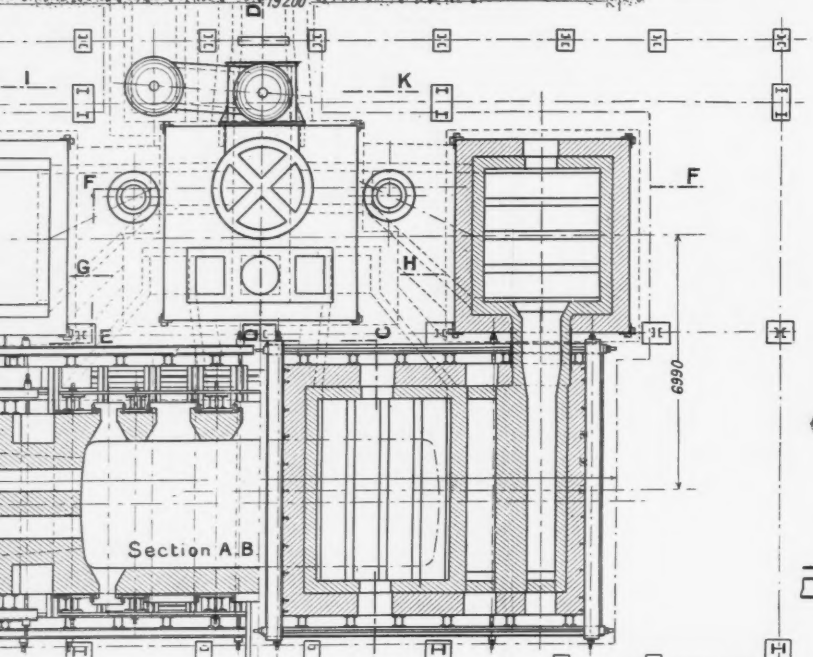



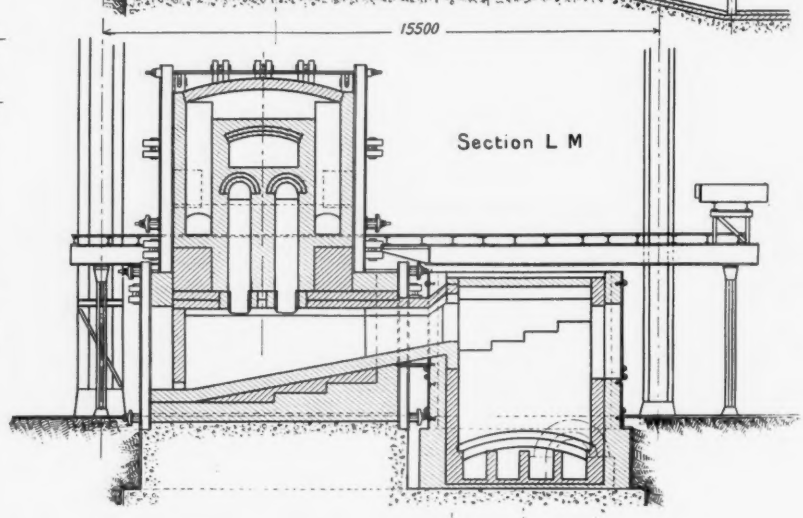

SWAIN Sc

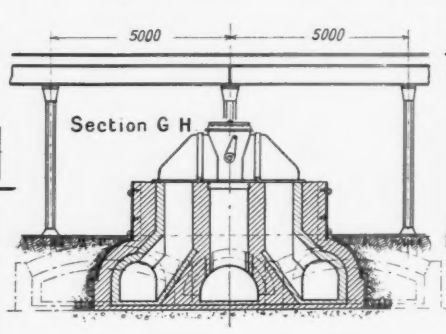
# MARTIN STEEL FURNACES AT GIO. ANSALDO e CO.'S WORKS

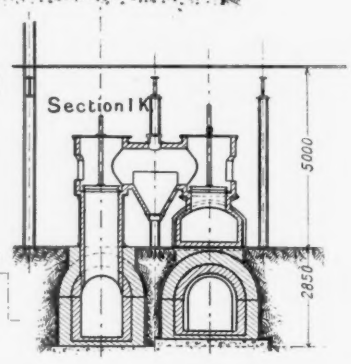


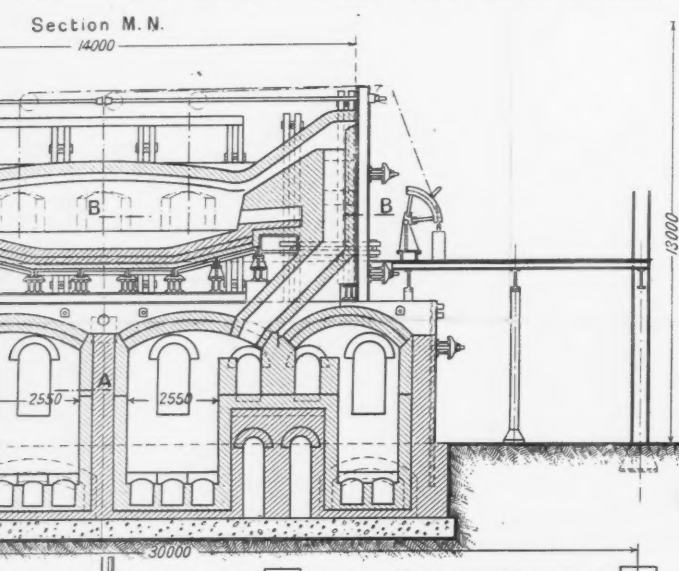



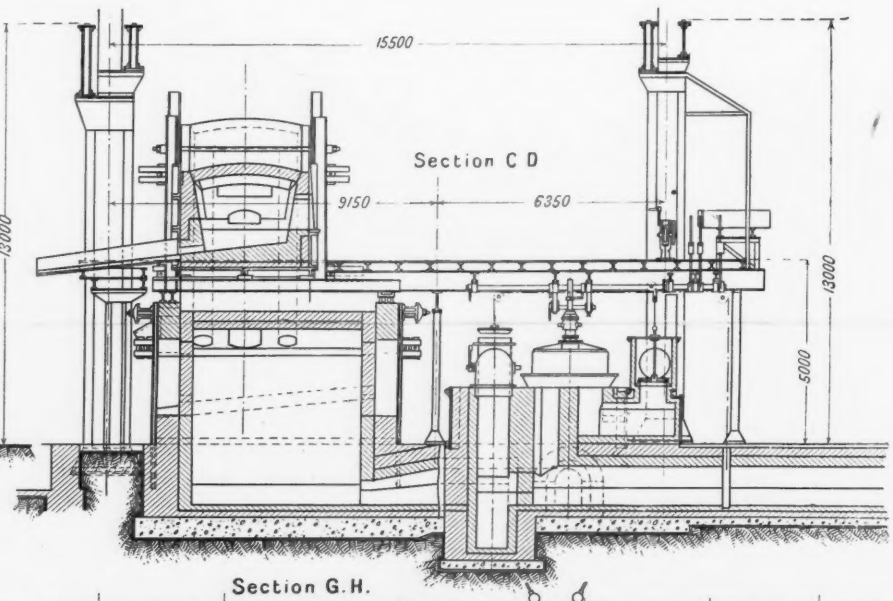



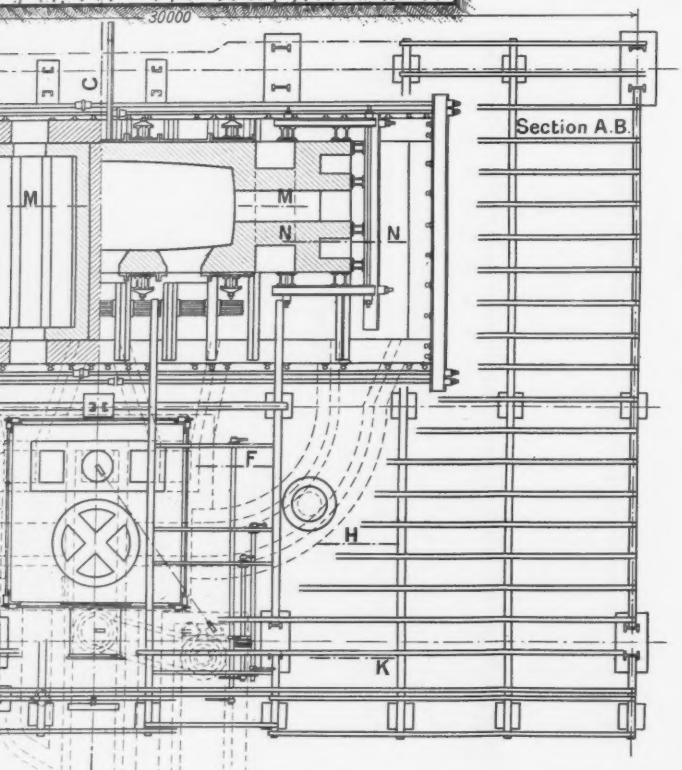



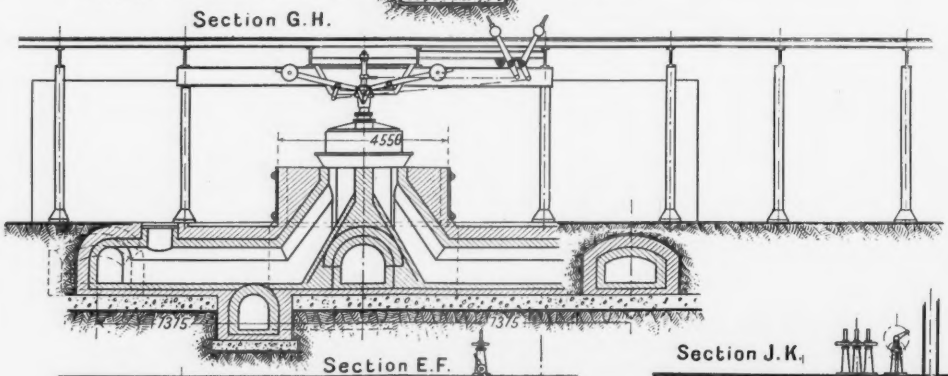



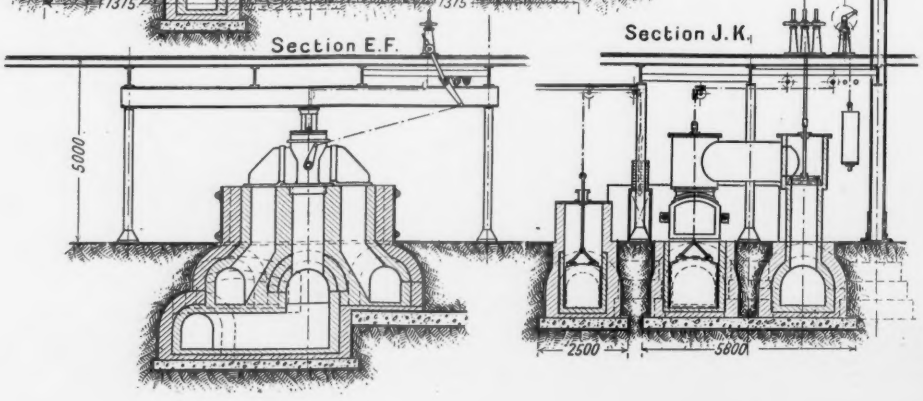



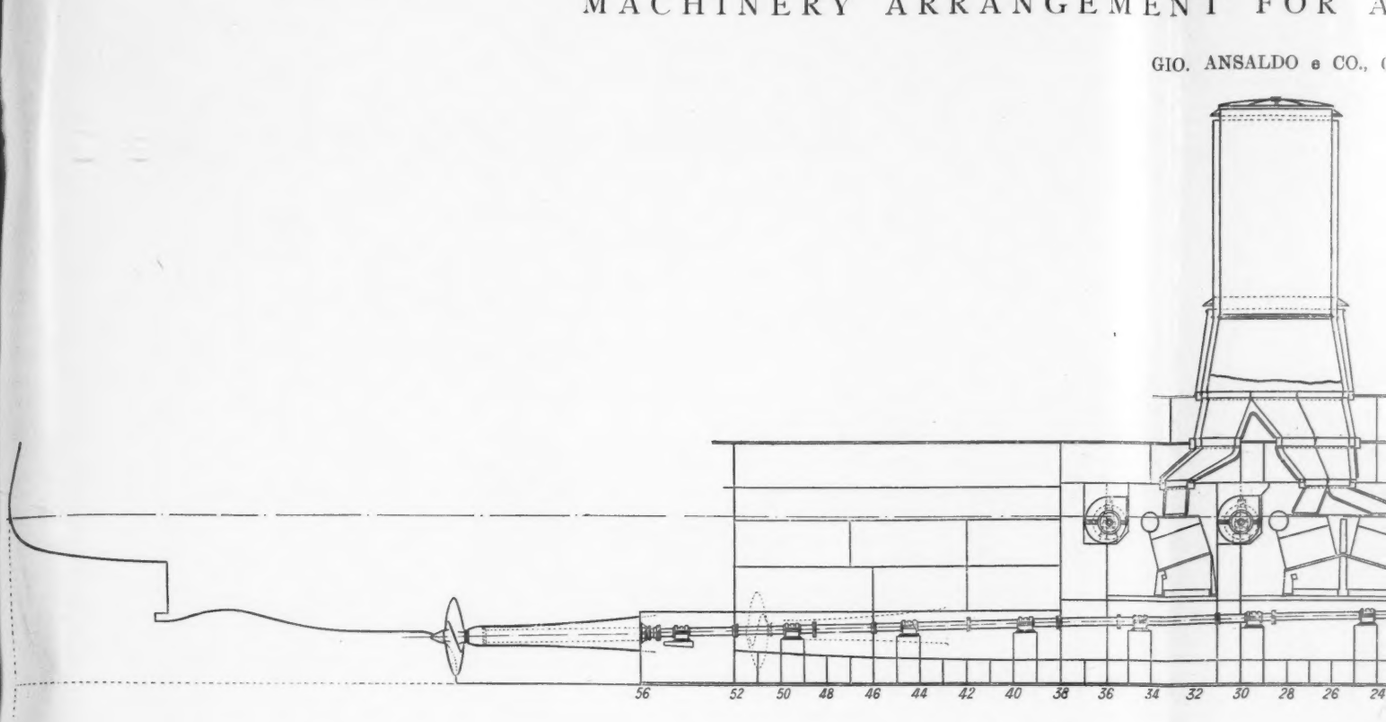



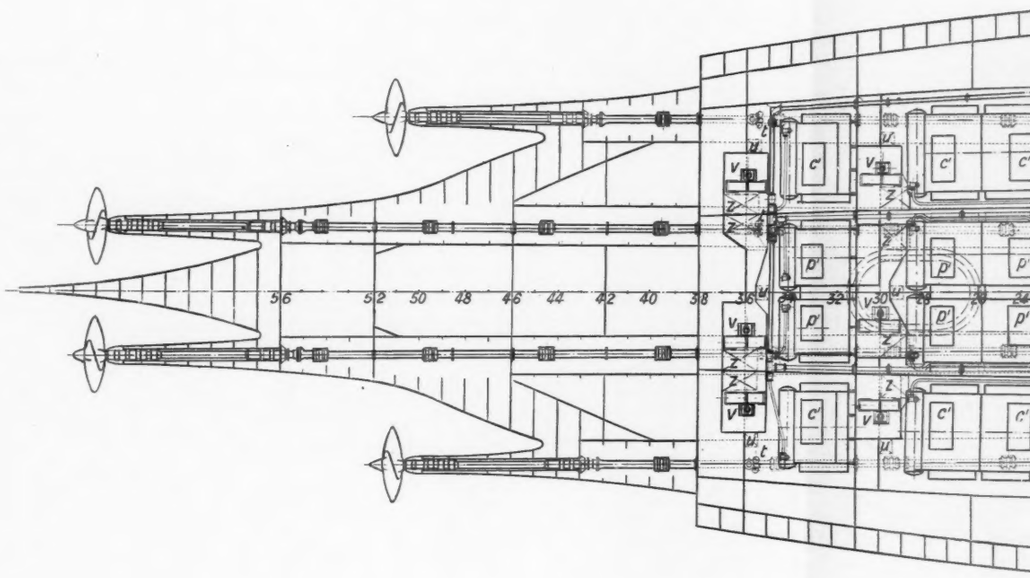

SWAIN Sc.

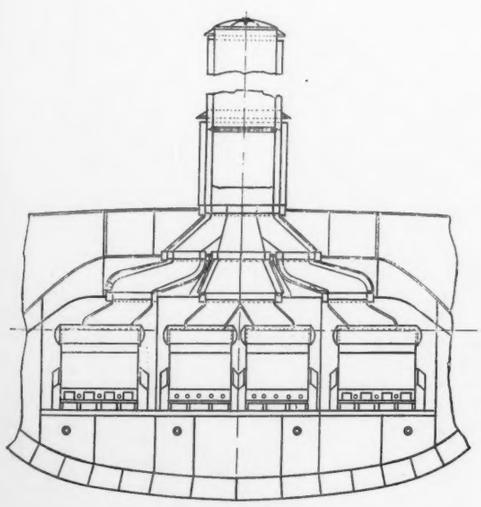
# MACHINERY ARRANGEMENT FOR A

GIO. ANSALDO e CO., G

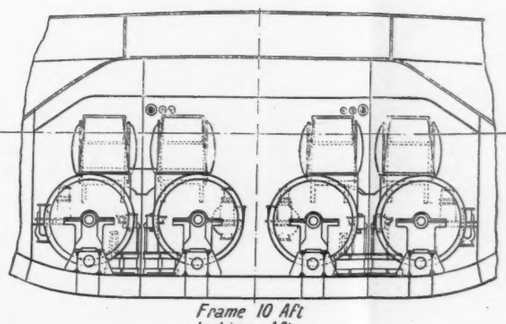



A = Turbine H.P.
B = .. M.P.
C = .. L.P.
D = Astern Turbine
E = Group of Gear
f = Turbine Starting Apparatus
g = Main Condensors
h = Circulating Pumps
k = Air Pumps
l = Feed Water Tank
m = Oil Cooler Pumps
n = Oil Coolers
o = Oil Pumps for Shafts
p = Auxiliary Condensors
q = Evaporators
r = Fire & Bilge Pumps
s = Bilge Pumps
t = Feed Pumps
v = Ventilators
u = Passage to Boiler Rooms
z = Ventilators



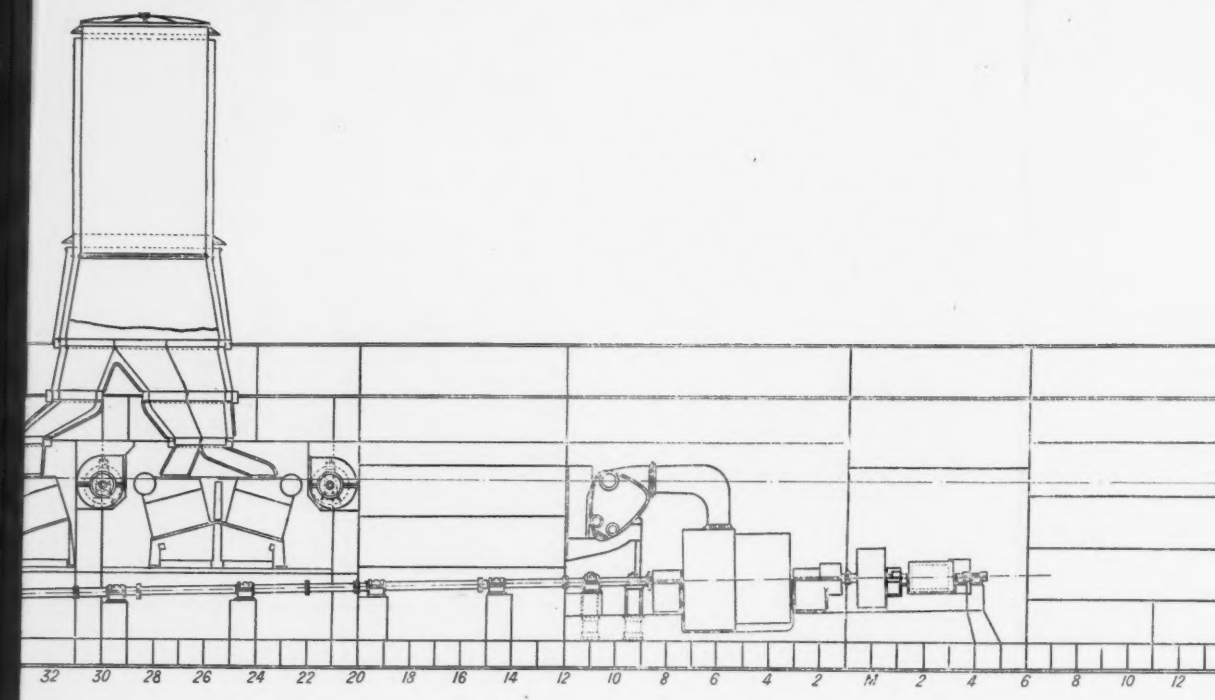
Frame. 29 Aft
looking Forward.



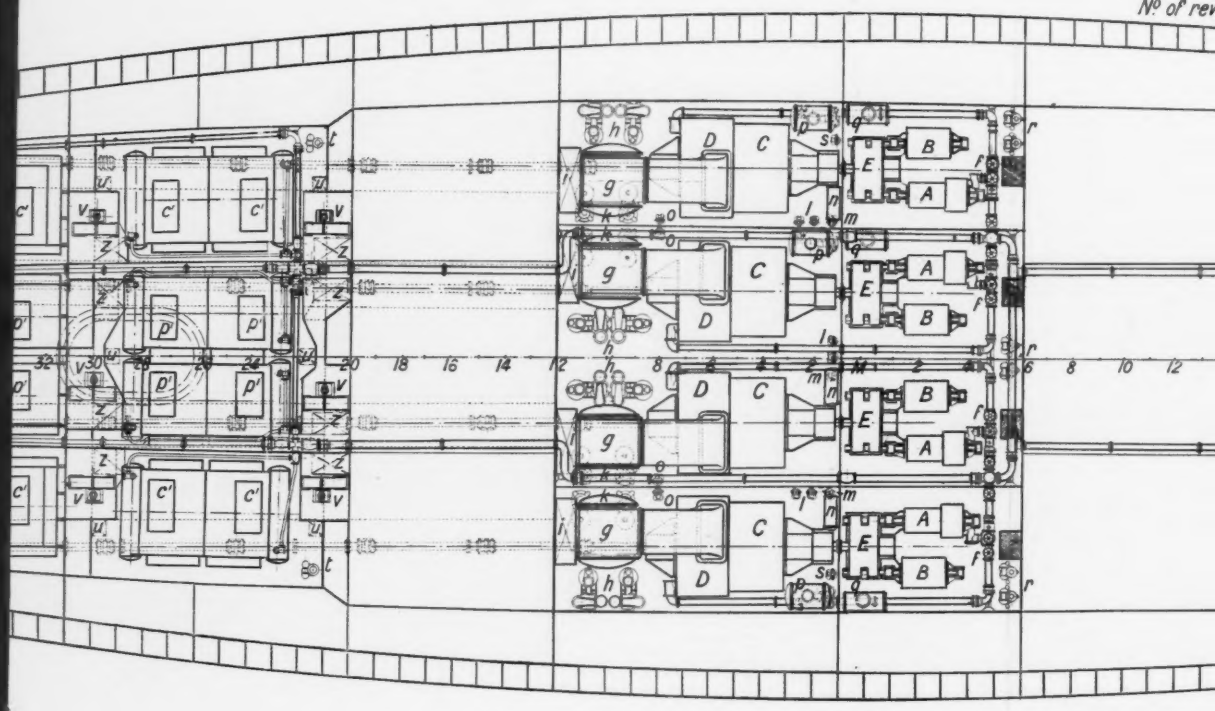
Frame 10 Aft
looking Aft.

# NT FOR A 48,000 HORSE-POWER BATTLESHIP

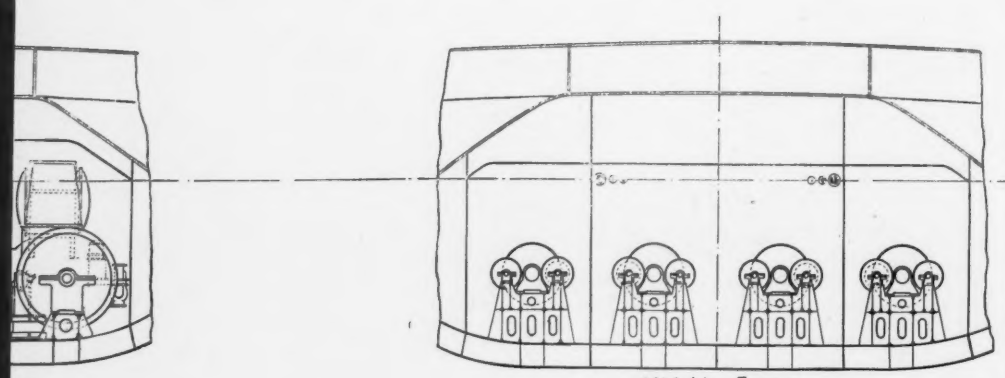
O. ANSALDO e CO., GENOA, ENGINEERS




Power of
Nº of rev

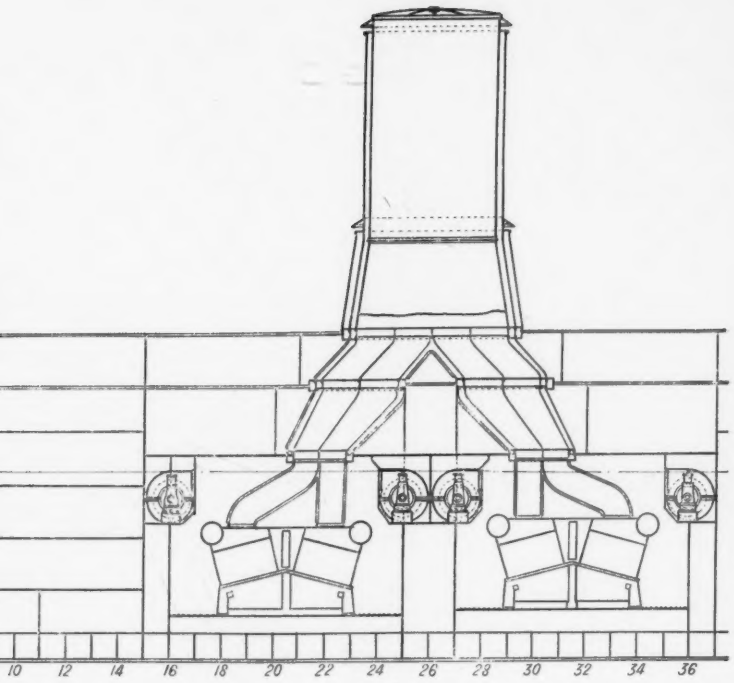



c'= Boilers for burning coa
p'= Boilers for liquid fuel w

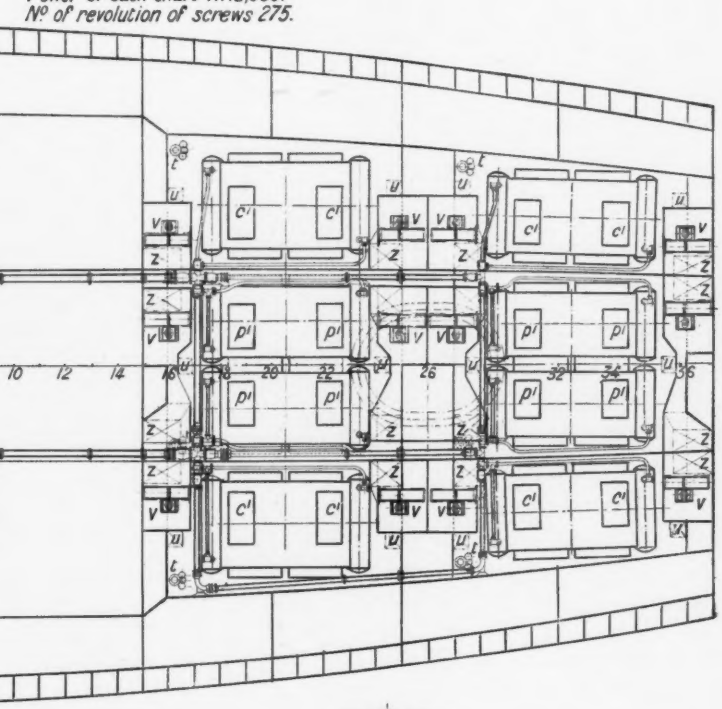


Midship Frame
looking Aft.

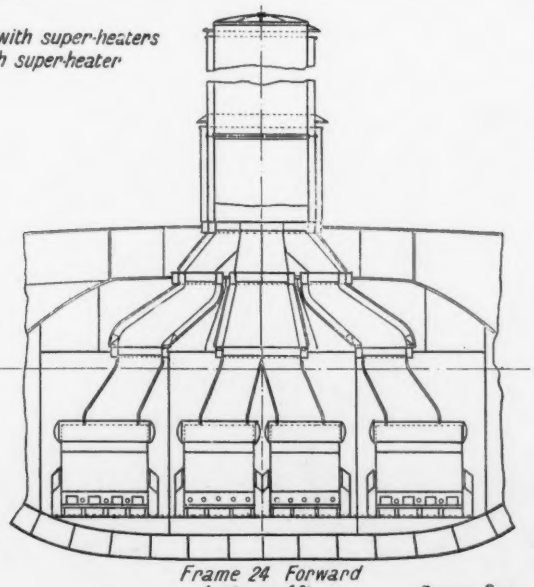
I P




Power of each shaft H. 12,000.
Nº of revolution of screws 275.




burning coal with super-heaters
liquid fuel with super-heater

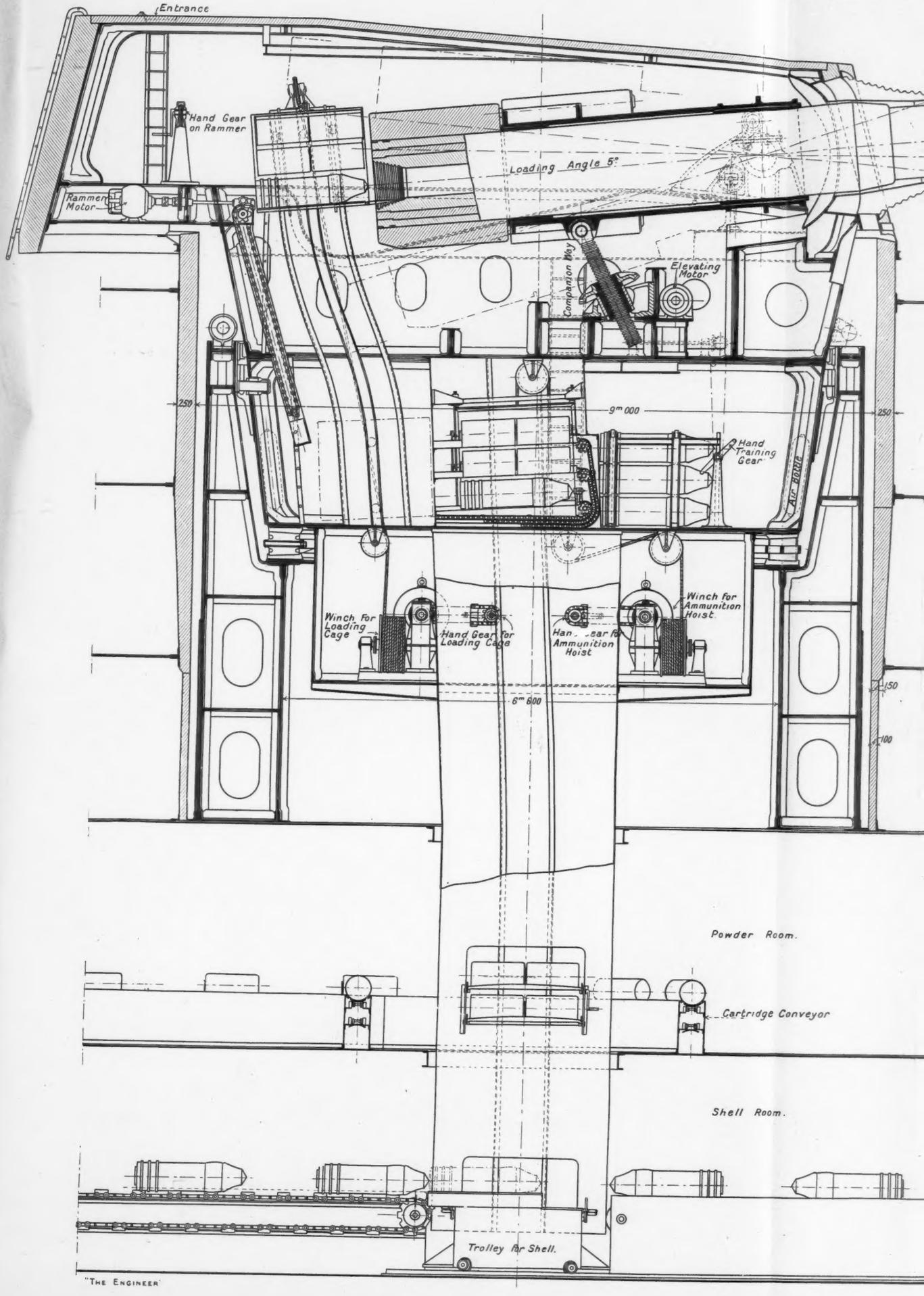


Frame 24 Forward
looking Aft.

SWAIN Sc.

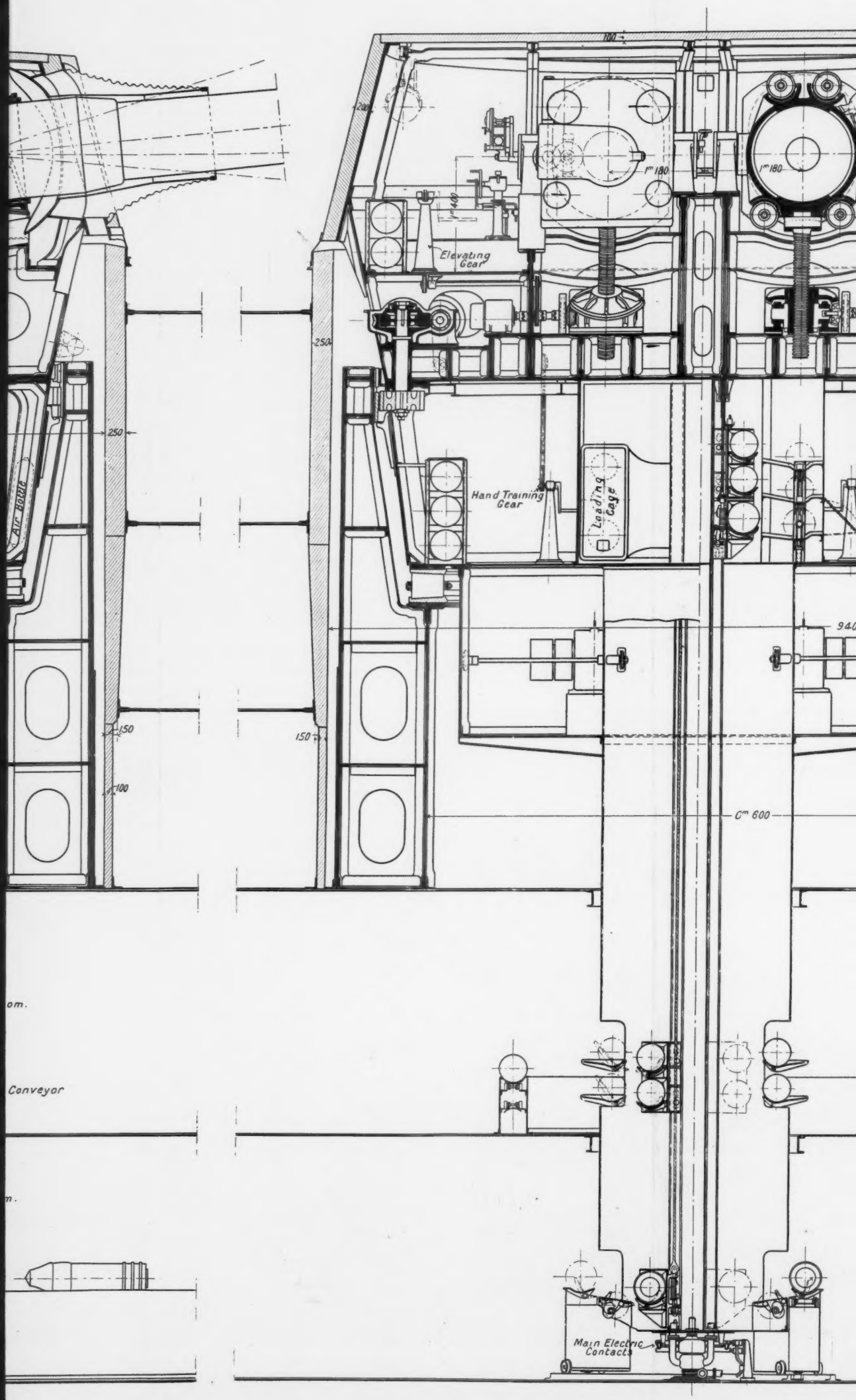
# 15 INCH NAVAL

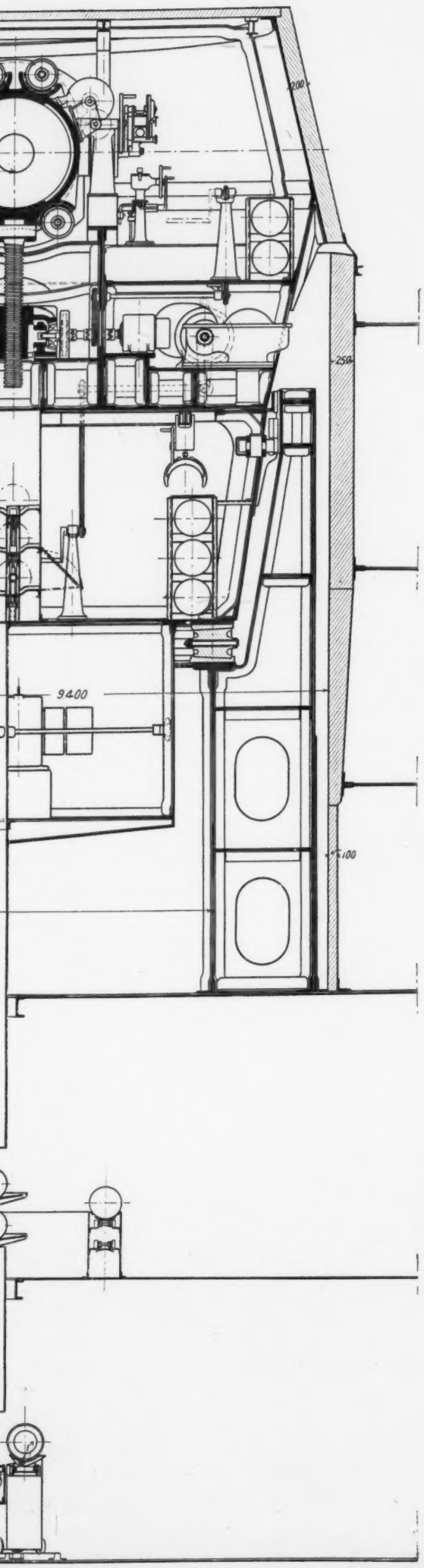
GIO. ANSALDO e CO.,



# NAVAL GUN MOUNTING

O. ANSALDO e CO., GENOA, ENGINEERS

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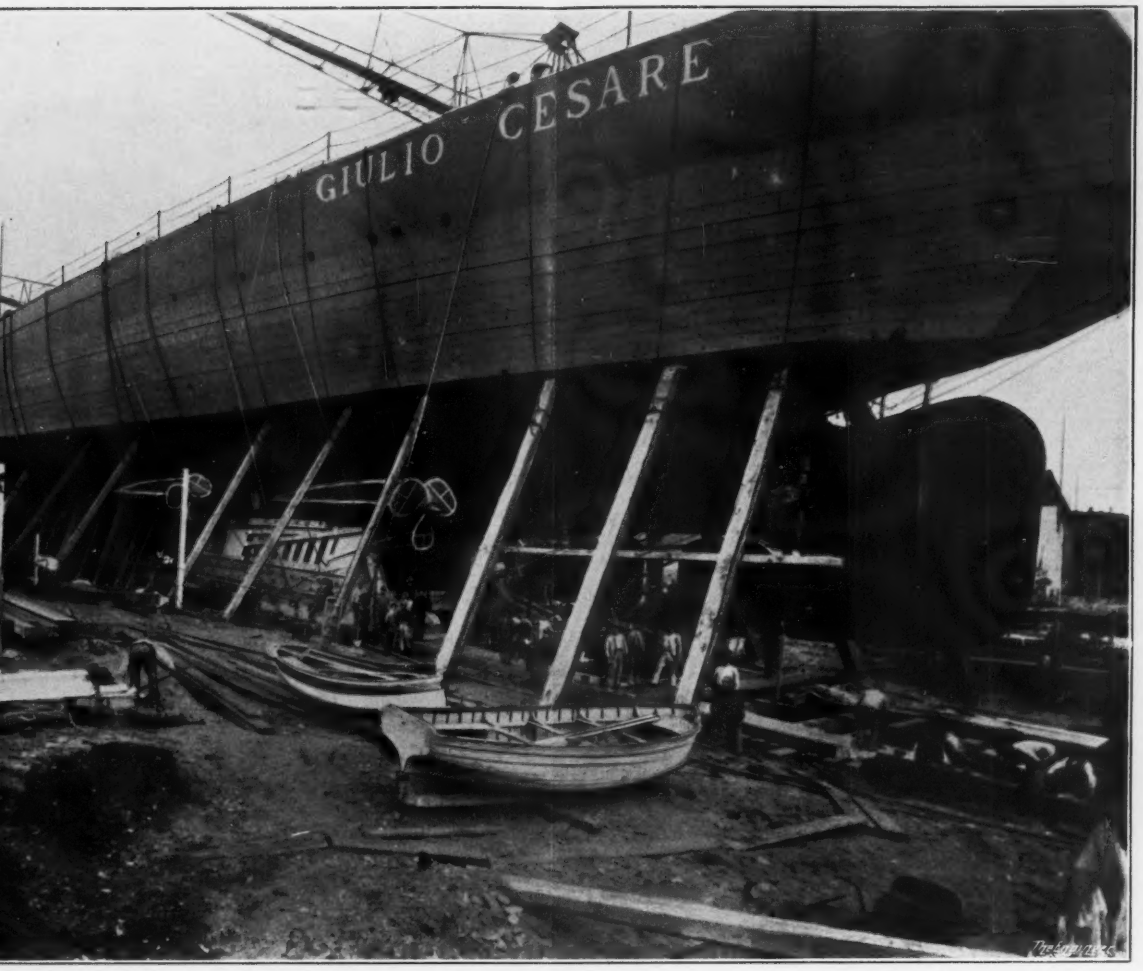
GIO

# THE ITALIAN BATTLESHIP GIU

GIO. ANSALDO e CO., GENOA, ENGINEE

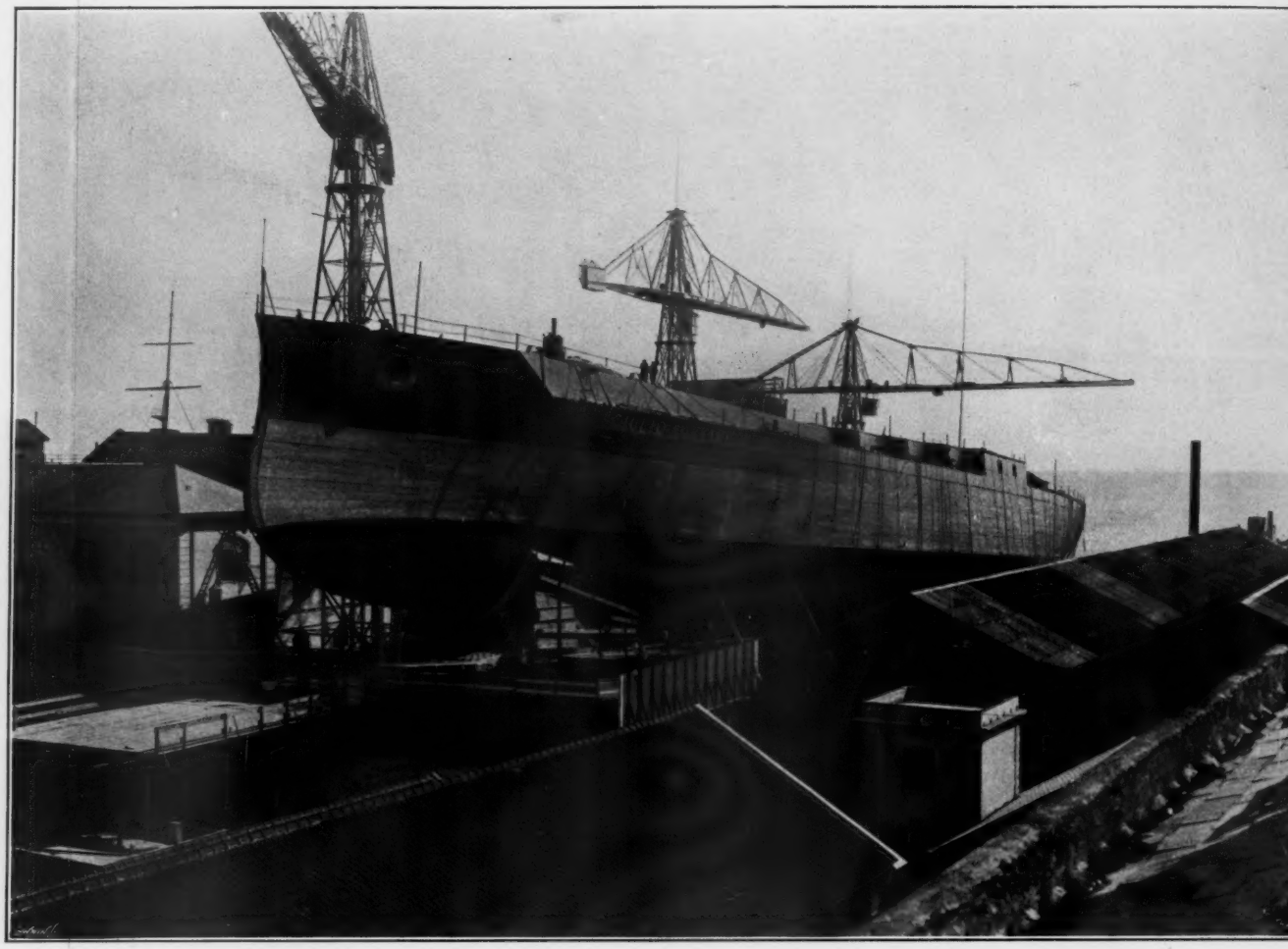


THE GIULIO CESARE ON THE STOCKS

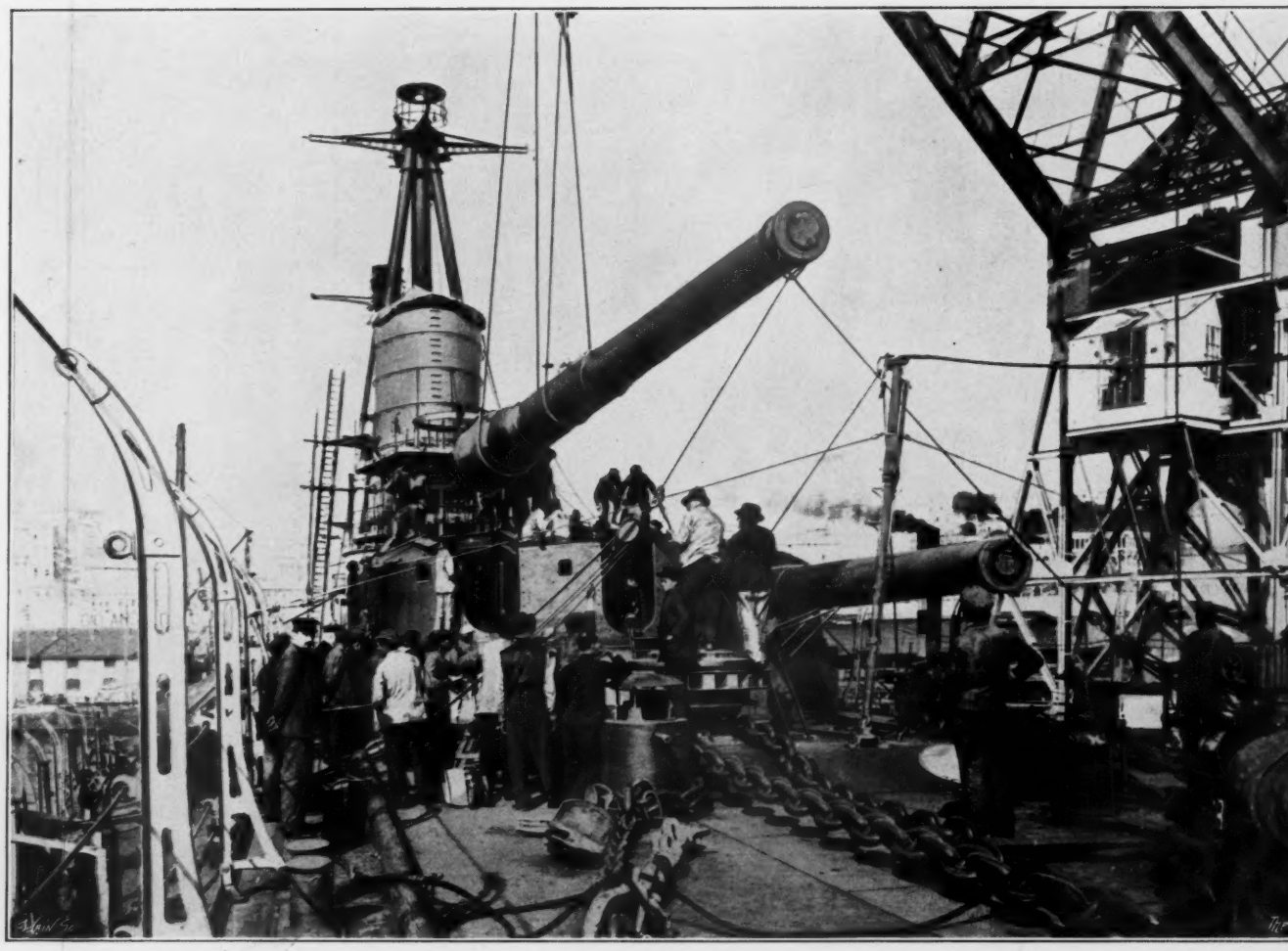
MOUNTING THE GUNS IN A TRIPLE TURRET OF THE

IAN BATTLESHIP GIULIO CESARE

GIO. ANSALDO e CO., GENOA, ENGINEERS



THE GIULIO CESARE ON THE STOCKS



ING THE GUNS IN A TRIPLE TURRET OF THE GIULIO CESARE

## THE BONECOURT SURFACE COMBUSTION PROCESS.

No. I.

THE modern tendency is ever to conserve the by-products of manufacturing processes, and in few directions is this more apparent than in the field of combustion. It is becoming daily more widely recognised that the burning of solid fuel is wasteful of ammonia, hydrocarbons, and calories, and the relatively antiquated use of solid fuel for power production and heating purposes is gradually but surely giving way to the use of gaseous fuel in its several forms.

The principal interest attaching to the process of surface combustion arises from the fact that by its use the advantages of gaseous combustion are retained, while, in addition, those advantages which were previously peculiar to the use of solid fuel are now obtainable in full degree from gaseous fuel. For example, until quite recently all gaseous combustion processes laboured under the disadvantage of yielding a low radiant effect, the result being that gas-fired boilers as a class were less efficient and more bulky than coal-fired boilers of equal power. Surface combustion produces with gaseous fuel a very high radiant effect, and the result is that surface combustion applied to steam generation enables boilers to be built for which it is claimed that they are more efficient and less bulky than any coal-fired boiler hitherto produced.

### THE PROCESS.

If the question be asked, "wherein does surface combustion differ from ordinary combustion?" the reply is that the differences are of two kinds. There is, firstly, the difference in the *modus operandi*; and secondly, a difference in the results produced.

We might take as an example of ordinary combustion a jet of gas burning at a batswing burner. The flame results from the oxidation of the gaseous fuel, the oxygen required being supplied from the surrounding atmosphere. The flame consists of a succession of gaseous envelopes containing combustible gas and oxygen in various proportions. The completion of the combustion depends on the molecules of gaseous fuel passing through sufficiently aerated zones before falling to a temperature below which oxidation will not take place. It therefore happens that if the flame be brought into contact with a cold surface, products of incomplete combustion result, their appearance being due to the cooling of part of the gaseous fuel before it has been given a sufficient opportunity of mingling in a heated state with atmospheric oxygen.

It is particularly to be noticed that in the case cited the air required for the combustion is not supplied to the zone of combustion in any positive manner. The ascension of the heated products of combustion draws in fresh supplies of air to the flame, or, in other words, the draught produced is the agency which feeds the flame with air. This somewhat adventitious method is the one which is mostly in vogue in industrial combustion processes. In other cases the gas flame is fed with air delivered in a more positive manner, as, for example, in the case of the ordinary blow-pipe, where a stream of air supplies the oxygen required for the oxidation of the fuel.

It is in the method of supplying the air and the combustible element to the zone of combustion that we find the first difference between the process of surface combustion and the process of ordinary flame combustion. In the former case the gas and air are thoroughly mixed together in the proportions theoretically required for complete combustion, the resulting mixture being a highly explosive one and constituting a self-burning medium—a medium, that is to say, which is ready to undergo complete combustion without accession of further air. The mixture is delivered, in such manner as to avoid pre-ignition, on to an incandescent surface which serves to accelerate its combustion.

The manner in which the gaseous mixture is delivered to the hot surface is of two kinds. According to the first process, the mixture is passed through a permeable septum of fire-clay and ignited on the face of exit, the exit surface of the septum being maintained incandescent by the combustion of the mixture, while the back surface of the septum is kept cool by the continued inflow of the cold gaseous mixture. The interstices in the septum, which are of capillary dimensions, exercise a cooling action on the gaseous mixture and thereby prevent any backward propagation of combustion. This process, by reason of the fact that a pervious fire-clay diaphragm is employed as the principal agent, is known as the "diaphragm process" of surface combustion, and has already found many industrial uses, to some of which we shall shortly refer.

The second method of supplying the gaseous mixture to the hot surface consists in supplying the mixture at a speed which is greater than the speed of its ignition. By this means the gaseous mixture travels to the hot surface at a speed which is greater than the speed with which combustion can take place in the reverse direction, and the mixture is thereby prevented from undergoing combustion until it arrives at the place where the hot surface is situated.

It will be seen that both these processes have this in common; that the gas and the air required for its combustion, are supplied in the form of a most intimate homogeneous mixture; that the gas and air constituting this mixture are present in the proportions theoretically necessary for complete combustion, and that a hot surface is employed for the purpose of determining and accelerating the combustion. The difference between the processes resides in the manner in which the gaseous mixture is supplied to the hot surface.

The method last described is the one which has come into use for the purpose of steam generation, furnace heating, and many other industrial operations. We shall refer to this process when describing its technical applications.

### THE DIAPHRAGM PROCESS.

The diaphragm process finds its most ready application in cases where heat is required in radiant form. The process affords an excellent means of obtaining an incandescent surface of considerable extent. The entire absence of flame makes for a high radiant efficiency, and it is this high degree of radiant efficiency which is the principal characteristic and advantage of the process.

Fig. 1 illustrates a diaphragm unit for the development of radiant heat for any required purpose. The apparatus simply comprises a casing in which the diaphragm is set, and to the back of which the gaseous mixture is supplied by means of a pipe. The mixture is produced by the confluence of gas and air supplies controlled by gas cocks. The diaphragm itself comprises a slab consisting of an agglomeration of fire-clay fragments of uniform size, held together with a ceramic cement employed in such small quantity that pores or interstices are left between the fragments, thus rendering the slab extremely pervious to the passage of gases. The porosity is such that a very

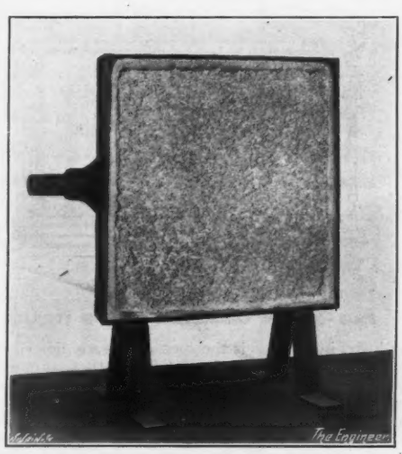


Fig. 1—DIAPHRAGM UNIT

low pressure of gaseous mixture behind the slab suffices to pass sufficient of the gaseous mixture to maintain the surface of the diaphragm in its full glow. It is therefore sufficient to supply air to the diaphragm at a pressure of 1in. or 2in. water gauge, the gas being supplied at the normal pressure obtaining in the town main. Another method of firing these diaphragms, whereby the use of air under pressure is obviated, consists in employing a gas pressure of 2 lb. to 4 lb. per square inch, together with an injector device whereby the pressure of the gas induces the necessary flow of atmospheric air into the back of the diaphragm casing. In either case the result, so far as the incandescence is concerned, is the same, the selection of the method to be employed in any particular case being simply a question of convenience, and being determined by the availability or otherwise of a low pressure air supply.

Diaphragm heating units of this kind can be employed with any form of gaseous fuel, provided it has sufficient calorific intensity to maintain the surface of the diaphragm in the necessary state of glow. Thus, with Mond gas the same incandescent effect and the same brilliancy are obtained as when using coal gas. With producer gas of lower hydrogen content, however, the incandescence is less bright, although in this case also the effect produced is for many purposes still a useful one. Petrol air gas also produces the same incandescence as does coal gas, and with this advantage, that it contains in itself nearly sufficient air for the combustion of its hydrocarbon content, and therefore it is only necessary to cause a slightly more aerified gas to be produced from the petrol air gas plant in order to obtain a self-burning gaseous medium which can be fed direct to the diaphragms without any further addition of air.

The appearance of one of these diaphragms at work when fired with any suitable form of gaseous fuel is that of an incandescent surface uniformly glowing with a bright red heat and entirely devoid of flame. Its appearance at once suggests the uses for which it is best adapted. It is clearly suitable for the development of heat in the form of radiant energy. In a word, the diaphragm is to the industrial world what the gas fire is to the domestic world. This form of heating element is coming into wide use for a considerable diversity of industrial purposes, *e.g.*, the boiling of solutions, the heating of dies by radiation, the drying of cores and moulds for steel castings, &c. The surface of the diaphragm does not deteriorate in use, nor does the texture become clogged with dust, so as to cause the porosity to diminish in course of time. Diaphragms have now been in regular use in certain industries for more than twelve months, without showing any serious signs of deterioration in any direction.

### SPECIFIC USES.

By way of mentioning more specifically one or two of the uses to which diaphragms have been put, it may be stated that one important firm has adopted them for the heating of extrusion dies, employing a hexagonal arrangement of six diaphragms, placed equally around the die so as to heat it by radiation from the hot surfaces, all of which are focussed to a common centre. For work of this kind an important point is the rapidity with which the heating may be developed to its maximum extent. From the moment of lighting-up the diaphragms it only takes about 1½ minutes for the attainment of the maximum glow.

In Fig. 2 is represented a diaphragm unit designed for boiling sugar solutions. The unit comprises a circular diaphragm surrounded by a brick-work setting, on which the pan containing the sugar solution rests. These boilers do each 10 to 12 heats

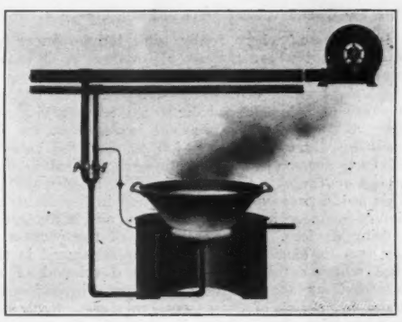


Fig. 2—DIAPHRAGM UNIT BOILING SUGAR SOLUTION

per day, each heat occupying 20 minutes, and the gas consumption per heat being 40 cubic feet of town gas. With the old arrangement of Bunsen burner, which was in use before these diaphragms were installed, the consumption of gas for the same work performed was exactly double, namely, 80 cubic feet per heat. Many of these diaphragms have been supplied to a large firm of sweet-stuff makers, which has now had the diaphragms in use for over twelve months, and is from time to time enlarging its installation of such heating units. In this installation the gas and air cocks shown in the figure as being separately controllable are united by a common hand lever, so that one movement of the hand suffices to turn on both the gas and the air supplies in the proper proportions. The moment this lever is pulled over and a match applied, the surface of the diaphragm begins to glow. In the space of 1½ minutes or thereabouts it has attained its maximum effect, and in 20 minutes, when the work has been completed, the lever is pushed back and the incandescence immediately disappears. The immediate response of the glowing surface to the turning on and off of the gas results from the fact that the incandescence of the diaphragm is situated only in the surface and does not extend to a greater depth within the texture of the diaphragm than about one-eighth of an inch, measured from the outer face.

The physical explanation for the large economy in gas consumption above mentioned is not far to seek. When a pan containing liquid is heated by a Bunsen burner only a small proportion of heat is transmitted in the form of radiant energy from the flame, the greater part of the heating taking place by reason of the contact of the hot products of combustion with the surface of the pan. Heat is not readily communicated in this way, as the effective transmission depends on the intimacy of contact of the hot gases with the pan surface. In the case of the diaphragm, however, the greater part of the heat utilised is transmitted from the surface of the diaphragm in radiant form, and the useful effect produced does not therefore depend in so great a degree on establishing contact between the pan surface and the hot gaseous products.

It might be objected that a porous diaphragm of the kind used is liable to be put out of operation by the accidental spilling of syrupy solutions on to its surface. This is not the case. It is not an infrequent thing for a pan of syrup to boil over and flood the surface of the diaphragm, but the liquid quickly evaporates and all that remains is a skin of carbon which soon burns away and leaves the surface just as it was

before. Accidents of such a kind do not impair the life of the diaphragm to any appreciable extent.

WORKING CONDITIONS.

Considerable improvements have been made during the past few months in the manufacture of these diaphragms, so that it is now possible to work them at higher temperatures than was the case at first. The safe limit of temperature which the radiating surface of the diaphragm can attain without risk of pre-ignition of the gaseous mixture is in the neighbourhood of 1000 deg. Cent. The actual temperature of the surface when the diaphragm is radiating freely into space lies between 800 deg. and 900 deg. Cent. When the diaphragm forms part of a heated enclosure, as, for example, when it forms part of the wall of an oven or drying chamber, the heat of the enclosure has the effect of conserving more heat upon the surface of the diaphragm, so that the temperature of the latter tends to increase somewhat. It is found that diaphragms are suitable for use in the construction of enclosures where the temperature in the enclosure is anything up to 500 deg. or 600 deg. Cent. If the temperature of the enclosure is higher, the combustion will gradually recede after a long time into the texture of the diaphragm, and ultimately ignition of the gaseous mixture will take place in the diaphragm casing. This renders the diaphragm unsuitable for the construction of furnaces which are required to work at high temperatures; but where the period of heating is a short one the temperature limits above stated may be exceeded. For example, it has been found that these diaphragms will heat an enclosure at 1000 deg. Cent. in cases where the heating is of an intermittent nature and the high temperature is only required for the space of half an hour or so.

THE SECOND PROCESS OF SURFACE COMBUSTION.

In all cases where really high temperatures are required and where the use of diaphragms is inconvenient for any reason, the alternative process is employed, which consists in delivering the gaseous mixture at a high speed on to the necessary incandescent surface. The physical explanation for the resulting flameless combustion is that the gaseous mixture burns on the incandescent surface in thin layers too quickly to enable flame to be propagated. This is the process which is applied in the construction of furnaces, in steam generation, and in numerous heating devices. The application of the process in any specific case consists in the arrangement in the zone where combustion is to be developed of an extended surface adapted to become incandescent under the action of the gaseous mixture. Such surface may be obtained by disposing in the required positions a bed or beds of refractory granules or fragments, or some other suitable conformation of refractory material. The gaseous mixture is supplied to the combustion zones from pipes which lead into refractory conduits of relatively small cross-section, thus ensuring a sufficiently high speed on the part of the gaseous mixture, as it gains admission to the combustion zone, to prevent combustion from receding in the direction contrary to the direction of supply.

FORGING FURNACE.

Furnaces operating on this principle have been constructed for a variety of uses. Fig. 3 is a drawing of one built for the heating of forgings. The fuel employed in this case is producer gas of low hydrogen content. The calorific intensity of the fuel being low, it is necessary to pre-heat the air and gas to some extent in order to obtain the high temperature required. This is accomplished by causing the air and gas supplies to traverse separate nests of iron pipes disposed in the path of the combustion products leaving the furnace on their way to the chimney. By this means the air is heated to a temperature of about 450 deg. Cent. and the gas to 300 deg. Cent, which is found sufficient to produce the required temperature of 1350 deg. Cent. in the furnace with a low gas consumption. The incandescent bed where the combustion is developed is in two parts, one on either side of the working space.

THE COMBUSTION PRODUCTS.

One point of considerable importance in this and other furnaces operating on the same general combustion principles deserves emphasis. The gas and air being thoroughly mixed so as to constitute a homogeneous gaseous medium before gaining access to the combustion zone, combustion is absolutely complete even though the air employed is not present in greater quantity than is required by theoretical considerations. Every molecule of combustible gas is surrounded in the most intimate manner by molecules of oxygen, and these assemblages in traversing the combustion zone have to run the gauntlet of an incandescent mass of refractory material, which ensures that no part of the combustible gas shall escape complete combustion. It therefore follows that the combustion products from a furnace of this kind are found to contain the maximum theoretical percentage of carbon dioxide to the complete exclusion of products of partial or incomplete combustion. This is a point of great importance in a large number of trades. In the enamelling industries, for example, until recently it has been necessary to employ muffle furnaces in the heating of the ware, so that the products of combustion are carefully excluded from contact therewith. It is found that if a muffle cracks, enabling part of the combustion gases to gain access to the interior of the muffle, the lead oxide in the enamel is reduced and the work ruined. The use of the muffle is necessitated by the fact that the combustion gases are not completely burnt, but contain traces of reducing gases, such as carbon monoxide. Having in view the completeness of the combustion obtaining in the surface combustion furnaces, it appeared that it might be found practicable to dispense with the use of muffles in enamelling operations.

ENAMELLING FURNACES.

With a view to determining this point in a conclusive manner, an important firm of enamelled ware manufacturers was approached and sent representatives to carry out a special test. The furnace

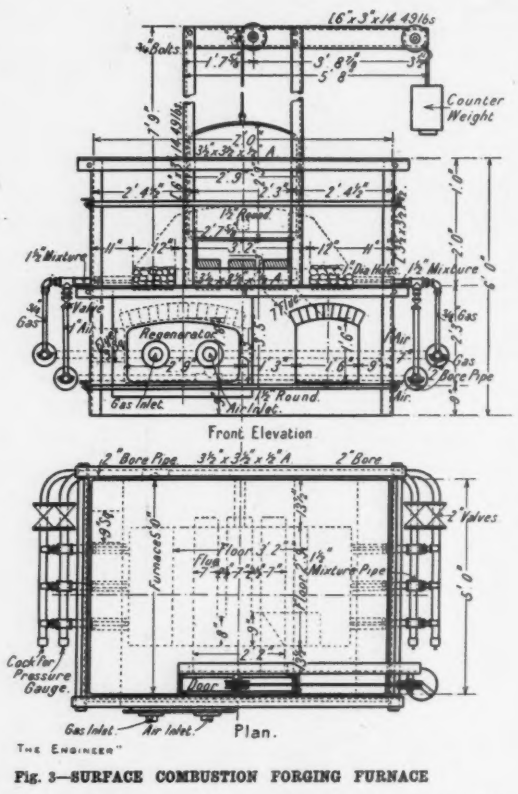
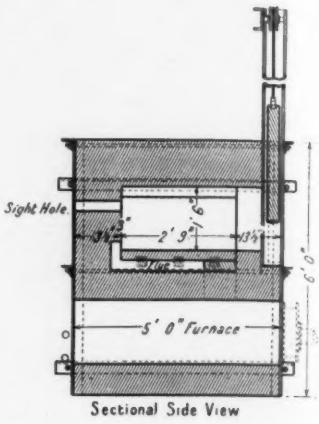



Fig. 3—SURFACE COMBUSTION FORGING FURNACE




employed in the test is the furnace already described and shown in Fig. 3. It was found that although no muffle was used, the combustion products therefore having free access to the work, the enamelled surface was not in any way impaired, thus establishing the fact that products of complete combustion do not interfere with the carrying out of this class of work, and that it is only reducing gases which render it necessary to protect the ware.

The importance of this point will be realised when it is considered that by the direct heating of the ware in furnaces of the type under consideration a very great saving in fuel is obtained. It is not possible at the moment to express this in an exact manner, but that the saving is very considerable will be fully appreciated when the low conductivity of fire-clay muffles is considered.

TEMPERATURES OBTAINABLE.

There are no limitations as to the nature of the gaseous fuel which can be advantageously employed

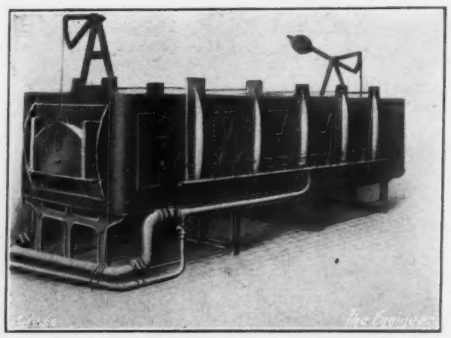


Fig. 4—FURNACE FOR ANNEALING RODS AND TUBES

in the process of surface combustion. So long as the gas is in any degree combustible it is available for use. The temperature obtainable is dependent on the calorific intensity of the gas, and as an approximate indication it may be stated that the temperature obtainable in a granular bed when burning blast furnace gas is in the neighbourhood of 1000 deg. Cent., in the case of Mond gas about 1500 deg. Cent., and in the case of coal gas, coke-oven gas, or water gas about 1950 deg. Cent. These are the highest temperatures obtainable in the combustion zone itself when pre-heating neither the gas nor the air, but these are not necessarily the temperatures produced in the working space of any particular furnace. The temperature produced in the working space will depend on the arrangement of the combustion beds and general construction of the furnace; but it is clear that the temperatures obtainable with the gases of higher calorific intensity are limited not so much by the nature of the combustion process itself as by the refractoriness of the materials which it is found practicable to employ in furnace construction.

ANNEALING FURNACES.

Fig. 4 is from a photograph of a furnace which has been installed in the Midlands for the purpose of annealing copper rods and tubes. It is fired with coal gas, the working temperature being 700 deg. Cent. The working space inside the furnace is 12ft. long, 2ft. 6in. wide, and 1ft. 3in. high. This furnace has now been in operation for some months, and it is found that it turns out the work at an unusually high rate, the normal gas consumption bein 800 cubic feet of coal gas per hour. No muffle is employed in this furnace, the combustion products having free access to the metal. In spite of this fact, no undue oxidation of the surface of the metal takes place, which is to be attributed to the low oxygen content of the combustion products.

Fig. 5 is from a photograph of a furnace which has been constructed for the so-called annealing process in the manufacture of malleable iron castings. The working space in the furnace, this being the space

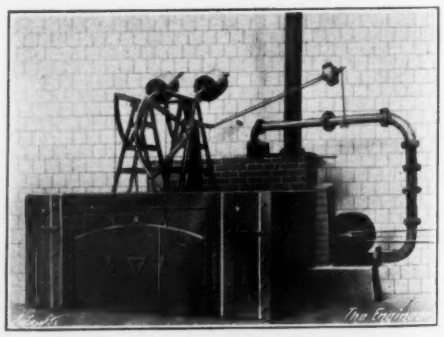


Fig. 5—ANNEALING FURNACE FOR MALLEABLE IRON CASTINGS

available for the reception of the iron pots which are charged with the castings to be treated, is 5ft. by 4ft. by 2ft. 6in. high. The pots are put into the furnace when cold, and the gas, which in this case is Mond gas, is supplied at the rate of 6000 cubic feet per hour for the first five hours. A temperature of 850 deg. Cent. having been attained, the rate of gas consumption is gradually cut down, and the consumption then maintained at 1500 cubic feet per hour for the last half of a total heating period of twenty-four hours. The arrangement of the gas and air supplies will be seen from the figure. The interior of the furnace is heated by two beds of refractory material disposed along the opposite sides and into which the gaseous mixture is injected. This furnace has given good results and is found to be convenient in practical use.

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IT is reported that the Brazilian Admiralty has decided upon the construction of a Dreadnought of 30,000 tons, to carry 15in. guns, to replace the Rio de Janeiro. It is further announced that the contract will be signed shortly by the Minister of Marine and a representative of Messrs. Armstrong, Whitworth and Co.

## IRON AND STEEL INSTITUTE.

### No. II.*

AFTER the reading of the presidential address and the presentation of the Bessemer Medal—matters with which we dealt in our last issue—Dr. Friedrich Schuster presented the first paper on the agenda, entitled,

"THE TALBOT PROCESS IN COMPARISON WITH OTHER OPEN-HEARTH REFINING PROCESSES."

With a view to solving the question of the best steel process to employ in the Witkowitz Ironworks, the firm, Mr. Schuster said, devoted a considerable amount of time and study to all previous forms of reverberatory furnaces, but the longer and more profoundly it considered the question, the more it recognised that a process, which, in the case of a particular steel works, gave perfectly satisfactory results from a qualitative point of view, as well as showing favourable figures for the cost of production, could not at once be applied where entirely different conditions prevailed. As a result of preliminary investigations, the firm soon arrived at the conviction that, for Witkowitz, the pig iron ore process was the only one possible, and it became a question of determining whether it would be more satisfactory to large scale comparative experiments, and it is with these experiments the paper deals. The main facts of importance may be gathered from the table and the author's conclusions given below. With regard to the table, the author says:—

Since the general level of the manufacturing costs at each individual works is influenced by the cost of production of the pig iron and the market price of scrap, and, further, depends on the price and quality of the coal employed and of the subsidiary material, wages, &c., I do not think it desirable to express in money the figures which apply to our case, and will restrict myself rather to giving the comparative figures obtained as a result of a long period of experiment.

If the total costs of production of steel as produced by the Talbot process be taken as equal to 100, the costs of production with the Wellman furnace rise to 105, and in fixed open-hearth furnaces to 107, including charges on account of working the mixer.

In order also to render possible a comparison with the conditions prevailing in West Germany, I have recalculated our effective working results, using the tables representing average values for the West German district, as given in the paper by Schock already mentioned, and taking as the basis of our working calculation the unit prices of material given in that paper. All those values, which refer to quantities, are the result of an exact determination over a long working period. The amounts for wages and miscellaneous expenses have been converted into marks, according to the actual attainable conditions. If, now, the costs of production obtained in this manner are compared with each other, and the costs of production for basic Bessemer steel are taken as 100, we obtain values which are again comparable, and working out at—for the scrap pig iron process, according to Schock, 129; for the pig iron ore process, 111, which may be taken as being too favourable; for the Talbot process, 114; for the Wellman furnace, 123; for the fixed open-hearth furnace, 128; and for the duplex process, 133. If in this series of values the cost of production by the Talbot process be again taken as equal to 100, the costs for the Wellman furnace come out at 108, and for the fixed open-hearth furnace at 112, in comparison with the values 100 : 105 : 107 as based on the Witkowitz conditions. The reason for this discrepancy is to be sought for simply in the difference in the manner of utilising the raw materials.

*Comparative Costs in Shillings.*

| | | Basic process (according to Schock's table.) | | | Scrap and pig process (according to Schock's table). | | | Pig and ore process (according to Schock's table). | | | Talbot process (New Steelworks, Witkowitz). | | | Wellman process (New Steelworks, Witkowitz). | | | Open-hearth process (New Steelworks, Witkowitz). | | | Duplex process (Old Open-hearth Works, Witkowitz). | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phosphorus in pig iron (approximate) | | 1.8 per cent. | | | 1.8 per cent. | | | 1.8 per cent. | | | 1.7 per cent. | | | 1.7 per cent. | | | 1.7 per cent. | | | 0.4 per cent. | | |
| Yield | | 89.5 ,, | | | 96.0 ,, | | | 107.0 ,, | | | 105.2 ,, | | | 104.4 ,, | | | 101.1 ,, | | | 88.0 ,, | | |
| Loss of balance | | 0.6 ,, | | | 1.6 ,, | | | 0.8 ,, | | | .. | | | .. | | | .. | | | 3.1 ,, | | |
| Daily production | | 1063 tons | | | 159 tons | | | 1484 tons | | | 295 tons | | | 175 tons | | | 300 tons | | | 514 tons | | |
| | Cost per ton, shillings. | Weight per ton of yield. | Shillings per ton of yield. Item. | Total. | Weight per ton of yield. | Shillings per ton of yield. Item. | Total. | Weight per ton of yield. | Shillings per ton of yield. Item. | Total. | Weight per ton of yield. | Shillings per ton of yield. Item. | Total. | Weight per ton of yield. | Shillings per ton of yield. Item. | Total. | Weight per ton of yield. | Shillings per ton of yield. Item. | Total. | Weight per ton of yield. | shillings per ton of yield. Item. | Total. |
| Charge. Basic pig iron | 44.0 | Kilos. 1090.0 | 47.96 | | Kilos. 260 | 11.44 | | Kilos. 813.0 | 35.77 | | Mixer costs. 878 | 3.80 | | Mixer costs. 837 | 3.45 | | Mixer costs. 738 | 2.57 | | 1068.1 | 47.0 | |
| Scrap | 56.0 | 20.0 | 1.12 | | 767 | 42.95 | | 115.6 | 6.47 | | 66 | 38.63 | | 114 | 36.82 | | 244 | 32.47 | | 56.1 | 3.14 | |
| Ferro-manganese | 200.0 | 6.5 | 1.30 | | 9 | 1.80 | | 6.0 | 1.20 | | 6 | 3.70 | | 7 | 6.38 | | 7 | 13.66 | | 9.0 | | |
| Ferro-silicon | .. | .. | .. | | .. | .. | | .. | .. | | .. | 1.20 | | .. | 1.40 | | .. | 1.40 | | 0.7 | 2.20 | |
| Spiegeleisen | .. | .. | .. | | .. | .. | | .. | .. | | .. | .. | | .. | .. | | .. | .. | | 1.3 | | |
| | | | | 50.38 | | | 56.19 | | | 43.44 | | | 47.33 | | | 48.05 | | | 50.10 | | | 52.34 |
| | | 1116.5 | | | 1036 | | | 934.6 | | | 950 | | | 958 | | | 989 | | | 1135.2 | | |
| Cost per ton of charge | | | (45.12) | | | (54.23) | | | (46.47) | | With mixer | (49.82) | | With mixer | (50.15) | | With mixer | (50.66) | | | (46.11) | |
| Cost per ton of scrap and pig | | | (44.21) | | | (52.96) | | | (45.80) | | Without mixer | (44.84) | | Without mixer | (45.42) | | Without mixer | (46.97) | | | (44.60) | |
| Oxides. Swedish ore | 28.0 | | | | | | | 150 | 4.20 | | 160 | 4.48 | | 165 | 4.62 | | 147 | 4.12 | | 27.2 | 0.76 | |
| 50 per cent. manganese ore | 42.0 | | | | | | | 18 | 0.75 | | | | | | | | | | | | | |
| Cinder (own) | 15.0 | | | | 35 | 0.525 | | 20 | 0.30 | | 44 | 0.66 | | 41 | 0.61 | | 27 | 0.41 | | | | |
| Cinder (bought, slag) | 17.0 | | | 0.525 | | | | 87 | 1.48 | 6.73 | | | 5.14 | | | 5.23 | | | 4.53 | | | 0.76 |
| Total ore and metal | | | | 50.38 | | | 56.715 | | | 50.17 | | | 52.47 | | | 53.28 | | | 54.63 | | | 53.10 |
| Lime | 12.0 | 150 | 1.80 | | 60 | 0.72 | | 125 | 1.50 | | 108 | 1.30 | | 116 | 1.39 | | 100 | 1.31 | | 78 | 0.93 | |
| Fluorspar | 25.0 | | | | 1 | 0.025 | | 1 | 0.025 | | | | | | | | | | | | | |
| | | | 1.80 | | | | 0.745 | | | 1.525 | | 1.30 | | | 1.39 | | | 1.31 | | | | 0.93 |
| Fuel. Cost of gasifying | | | | | | | | | | | | 0.98 | | | 1.15 | | | 1.37 | | | | |
| Coal | 19.0 | | | | 220 | 4.13 | | 220 | 4.18 | | 221 | 4.20 | | 260 | 4.94 | | 307 | 5.84 | | 267 | 5.07 | |
| Coke, graphite, wood, &c. | | | 0.24 | | | 0.125 | | | 0.10 | | | | | | | | | | | | | |
| | | | 0.24 | | | 4.305 | | | 4.28 | | | 5.18 | | | 6.09 | | | 7.21 | | | | 5.07 |
| Refractory material. Chrome ore | 65.0 | | | | 1 | 0.065 | | 1 | 0.065 | | | | | | | | | | | | | |
| Refractory material for furnace | | | | | | 0.90 | | | 1.60 | | | 1.40 | | | 2.45 | | | 2.52 | | | 2.85 | |
| Refractory material for working | | | 0.35 | | | 0.20 | | | 0.35 | | | | | | | | | | | | | |
| Dolomite tar, including wages | | | 0.70 | | | 0.60 | | | 0.60 | | | | | | | | | | | | | |
| | | | 1.05 | | | 1.765 | | | 2.615 | | | 1.40 | | | 2.45 | | | 2.52 | | | 2.85 | |
| Various expenses. Steam, gas, electricity | | | 0.50 | | | 0.17 | | | 0.20 | | | | | | | | | | | | | |
| Tools, stores, and spare parts | | | 0.40 | | | 0.50 | | | 0.50 | | | 1.71 | | | 1.71 | | | 1.62 | | | 2.23 | |
| Other operations, wages, material | | | 1.00 | | | 1.00 | | | 1.00 | | | | | | | | | | | | | |
| Direct wages, salaries, bonus | | | 0.95 | | | 2.00 | | | 1.50 | | | 2.28 | | | 2.40 | | | 2.46 | | | 5.52 | |
| Ingot moulds | | | 0.50 | | | 0.50 | | | 0.50 | | | 0.50 | | | 0.50 | | | 0.50 | | | 0.50 | |
| General, royalty, depreciation, &c. | | | | | | | | | | | | | | | | | | | | | | |
| | | | 3.35 | | | | 4.17 | | | 3.70 | | | 4.49 | | | 4.61 | | | 4.58 | | | 8.25 |
| Gross cost of production | | | | 56.82 | | | 67.70 | | | 62.29 | | | 64.84 | | | 67.82 | | | 70.25 | | | 70.20 |
| | 20.0 | 230 (17 p.c.) | 4.60 | | | | | | | | | | | | | | | | | | | |
| | 3.0 | | | | 140 | 0.42 | | | | | | | | | | | | | | | | |
| Less—Value of slags | 23.50 | | | | | | | 145 (18.5 p.c.) | 3.40 | | | | | | | | | | | | | |
| | 2.50 | | | | | | | 165 (6.9 p.c.) | 0.41 | | 187 (19 p.c.) | 5.15 | | 250 (13 p.c.) | 3.50 | | 210 (14 p.c.). | 3.20 | | | 0.52 | |
| Steam and waste heat utilised | | | | | | | | | 0.48 | | | | | | | | | | | | | |
| | | | 4.60 | | | | 0.42 | | | 4.29 | | | 5.15 | | | 3.50 | | | 3.20 | | | 0.52 |
| Net cost of production | | | | 52.22 | | | 67.28 | | | 58.00 | | | 59.69 | | | 64.32 | | | 67.05 | | | 69.68 |
| Cost of conversion (referred to 1 ton of scrap and pig | | | | Average 54.18 | | | | | | | | | | | | | | | | | | |
| | | | | 8.01 | | | 14.32 | | | 12.50 | | | 14.85 | | | 18.90 | | | 20.08 | | | 25.08 |
| | | | | 8.83 shillings | | | | | | | | | | | | | | | | | | |
| Comparative cost of production | | | | 100 | | 104 | 129 | | | 111 | | | 114 | | | 123 | | | 128 | | | 133 |

### CONCLUSION.

In finally summing up the results of our various experiments, I wish first of all to emphasise the fact that any conclusions drawn from them apply strictly only to our Witkowitz conditions, and assume an average daily production of from 800 to 1000 tons of steel; and that mathematical divergences from our conclusions may result on repeating these experiments in a different locality and under different conditions. Apart from this, however, we may arrive at a number of conclusions which may claim to be generally applicable. Taking for granted the above remarks, we have been able to find:—

(1) By using a mixer—capable of being heated—and carrying out but a small amount of refining in the same, the production of the steel furnaces supplied by it can be increased by about 30 per cent.

(2) The quality of steel produced is, both physically and chemically, independent of the choice of furnace employed.

(3) The yield is influenced by (*a*) the pig iron employed, and (*b*) the ratio of scrap to mixer iron and pig iron respectively; and such yield is practically the same whenever the same conditions are observed in furnaces of different types.

(4) The Talbot furnace is the type most adaptable to the working up of pig iron of varying composition, and to changes, within fairly wide limits, in the amount of scrap added.

(5) In the Talbot furnace, pig iron of the lowest to the highest phosphorus content can be worked up without deteriorating the quality of the steel, the decline in output with pig iron rich in phosphorus being smaller than in the case of other types of furnace.

(6) Although the actual first cost of the Talbot furnace is appreciably higher than that of a tilting furnace of small capacity or of a fixed open-hearth furnace, these costs, calculated per ton produced daily, work out most favourably for the Talbot furnace.

(7) The yield of metallic iron from the oxide additions—ore and cinder—is higher in the Talbot furnace than in other types.

(8) The slag produced in the Talbot furnace is, owing to the concentration of the phosphoric acid when using pig iron of high phosphorus content, more valuable than in other types of furnace; and therefore the gain arising from the sale of the slag is greater.

(9) The fuel expenditure is lower in the Talbot furnace than in the other furnaces.

(10) The life of the refractory lining is longer in the Talbot furnace than in other systems, and thus both the charges for repairs and the total consumption of refractory material for working come out most favourably in the case of the Talbot furnace.

(11) The working of the furnace is, in the case of the Talbot furnace, most simple and convenient, especially on account of the easy removal of the slag by tipping the furnace.

(12) The work of the furnace staff is less trying with the Talbot furnace than with the remaining types; and the number of persons necessary for carrying out the process is, relatively, the smallest.

From what has been said, it may safely be maintained that for open-hearth steel works producing medium and large quantities, the Talbot furnace is superior to all other types, so work with fixed or tilting open-hearth furnaces. Favourable reports were to hand from England and America concerning the use of tilting furnaces; but a difficulty was raised by the fact that, in spite of the gradually increasing production of open-hearth steel in Germany, this type of furnace was practically nowhere employed. With regard to the Talbot process—only practicable in tilting furnaces—a fact in its disfavour was that, apart from America and England, it had not been able to find a footing in the other steel-producing countries, in spite of various reports upon the favourable results obtained with it. In spite of these by no means encouraging facts, it was decided to make an exhaustive investigation of the Talbot process and its application to Witkowitz conditions; and with this object steel experts made repeated visits to England and America, and also to Senelle, and ultimately Professor Eichhoff, conjointly with Mr. von Maltitz, gave an expert opinion in favour of the adaptability of the Talbot process, with certain important modifications, to meet the local conditions. As the result of all its studies, the firm recognised that it would have itself to elaborate the most suitable process for its conditions, employing generally recognised principles, and arrive at the basis of the final arrangement of its steel works by that it may reasonably be described as the open-hearth furnace of the future.

Mr. Benjamin Talbot said that Dr. Schuster had started out by sending a Commission all over the steel-making world to ascertain what was being done and said with regard to the various processes. The result of that Commission appeared to him to have been that Dr. Schuster did not rely entirely upon any of the reports, because he stated in his paper that everybody had different ideas, so he decided to build a new plant in which the various processes could be satisfactorily compared. One had only to look over the plans to realise that at Witkowitz there had been built a magnificent open-hearth shop, containing every modern idea and labour-saving appliance. Of course, in a works of the character of Witkowitz, with the varied trades supplied there, several fixed furnaces working special mixtures and alloys would be sure to be useful. However, he would like to call the attention of the members to the plans of the furnaces, and especially to the areas given for the regenerators of the various furnaces illustrated. It would be noticed that the regenerators of the 60-ton tilting furnace were as large as those of the 200-ton tilting furnace, which confirmed what he (Mr. Talbot) had previously written and said upon the subject. After nearly twelve months' work, Dr. Schuster had proved

* No. I. appeared May 8th.

conclusively that the quality of the steel obtained by the Talbot process was equal to that obtained from the other two systems, and as steel for weldless tubes had been got from the Talbot furnace, he thought Dr. Schuster had given the steel every test that was necessary. The various grades of steel made had been tabulated, and the list could certainly be described as of a miscellaneous character. There was also a comparison of costs of construction, and Dr. Schuster's figures amply confirmed the claim that in large modern open-hearth shops, dealing with liquid iron, the Talbot process, with the 200-ton tilting furnace would be more economical to build than the 60-ton to 80-ton tilting or fixed furnace for the same large output. Dr. Schuster gave the comparative figures of cost per ton of output in the ratio of 882 for the Talbot, 1070 for the 60-ton Wellman, and 1000 for the fixed furnace—that was satisfactory. The table giving all the materials used in making a ton of steel proved that less fuel, oxide, lime, refractory material, and "ferro" were required. It was also the fact that with less lime, oxide and refractory material used with the same metal, there was a less volume of basic slag, and therefore the phosphoric acid in the slag was higher and the slag more valuable and would yield a larger credit to the account. The question of the quality of slag would, he hoped, now be finally settled, especially for German critics. Turning to the question of upkeep and durability of the brickwork and lining, a question which had caused perhaps more discussion than any other, Dr. Schuster's paper gave the tonnage obtained from one lining in each process, the results being:—The Talbot furnace, 52,000 tons (amended figure); the Wellman, 27,600 tons; the fixed open-hearth furnace, 27,800 tons. That showed what could be obtained when using suitable liquid metal, which required the minimum of lime and oxide. Dr. Schuster had referred to an important detail, namely, the lining of steel ladles, and was correct in stating that the cost of upkeep of the ladles used in the Talbot process was much less than of those used in the ordinary basic processes. That was due to the absence of slag in the ladles. With reference to cost, naturally the author did not give his own figures. He, however, gave comparative figures, which were very useful. If the Talbot process cost was given as £100, then under the conditions at Witkowitz the 60-ton tilting furnace came out at £105, and the fixed open-hearth furnace at £107. With regard to the so-called mixer, or continuous preliminary refining furnace, the author's remarks were very interesting. Dr. Schuster stated that its chief use was for storage and mixing, and that only a minimum amount of refining was done, and yet with that small amount of refining, an increase of 30 per cent. of output was obtained from the steel furnace. But was it a small amount of refining? The analyses of the pig metal poured into the preliminary refiner and of the metal used in the steel furnace were given in the paper. The pig metal was good basic or Thomas metal, and the effect of working in the preliminary furnace was to reduce the silicon about 60 per cent., and the sulphur and manganese about 40 per cent. Fortunately, sufficient work was done upon the silicon and sulphur without appreciably touching the phosphorus, as there would have been a loss in taking out part of the phosphorus and so reducing the percentage of phosphorus in the steel furnace and in the resulting slag, as the basic slag was so valuable. It appeared to him that Dr. Schuster was quite right in cutting down the refining in the preliminary furnace. If more work were desired in the preliminary furnace, then that furnace should be made larger if the same output were required. Again, the results showed how desirable it was to have a good quality of liquid metal for basic steel-making, and they were fortunate upon the Continent to be able to get it at a reasonable cost. Dr. Schuster had referred to the introduction of Bessemer converters as preliminary refiners for open hearth furnaces in the United States, and had pointed out that at Witkowitz they had used that method for many years, but abandoned it in their new plant because of the increased cost of making steel. At two works in America where the Talbot process was used, the Bessemer converter fed the steel furnaces, and enormous outputs were obtained—as much as 5000 tons per week from one 200-ton Talbot furnace. In conclusion, Mr. Talbot remarked that he did not think anyone using small tilting furnaces would drain them dry after each heat, which was obviously a foolish thing to do, as it took time and put an unnecessary strain upon the furnace lining, and, again, even a small amount of metal with a covering of slag was useful if retained in the furnace to help along the next heat. He thought Dr. Schuster had tabulated his conclusions in excellent form, and he entirely agreed with them.

Mr. Otto Frick commented on the rareness with which so many practical data were collected together and given openly to competitors as in this case. Dr. Schuster had taken a course which was calculated to benefit the whole industry. On looking through the tables most members would agree with the conclusions stated bearing in mind the conditions under which the work had been carried out, but he noted that whilst a great deal of information had been given, the paper did not state the reasons why this process was better than others. It was interesting to compare the different furnaces which had been installed at Witkowitz. It would appear that the Talbot furnace had a surface of 53 square metres, and the other furnaces surfaces of 36 square metres and 33 square metres. The average depth of the bath was 167 mm. for the Talbot and 237 mm. for the others. It was clear that in open-hearth furnace practice the object was to transfer the heat from the furnace to the bath, and the shallower the bath the more heat could be got into it. In this respect, the Talbot furnace enjoyed an advantage. With regard to scale and ore, the addition had been practically the same per ton of pig added in each case, and it was certainly astonishing to find that notwithstanding that the other furnaces had less pig and about the same amount of lime added, yet the amount of slag produced was very much higher. In the Talbot furnace it was 213 kilos., and in the other furnaces about 290 kilos. per ton of steel. The extra slag in those cases probably came from the roof. If an estimate were made of the amount of slag per square metre of surface the comparison was favourable to the Talbot furnace. The most important point of all perhaps was the coal consumption. Taking the amount of coal that was burnt in twenty-four hours, he found in the case of the Talbot furnace it was 66 tons, and in the case of the others 46 tons. That implied that the other furnaces were so designed that they could not utilise more than 46 tons of coal per day, and to obtain a proper comparison it would be necessary to put down furnaces which would use the same amount of coal. Another interesting point was as to the surface of bath per ton of coal which appeared to be somewhat smaller in the Talbot furnace than in the others; indeed, all the points which were of importance for distributing the heat to the bath were in favour of the Talbot furnace. He had tried to calculate the length of time the gases remained in the bath, and assuming 36 cubic metres of gas per kilogramme of coal at 170 deg. Cent., then in the Talbot furnace the gas remained in the bath about 4.4 seconds, and in the others about 3.5 seconds. Dr. Schuster dealt with the question of costs, and he gathered from the tables that the steel cost about M.15 per ton in the Talbot and about M.19 per ton in the Wellman furnace. Another point related to the possibility with the Talbot furnace of obtaining the desired production without straining the furnace.

Mr. T. C. Hutchinson, after referring to the debt of gratitude which the industry owed to Dr. Schuster, said he would like to ask the author one or two questions. It was stated that in some cases up to 50 per cent. of the original sulphur content had been eliminated during the transport of the pig iron in the ladles. He gathered that that was due altogether to the movement of the particles as the metal was carried, and it seemed to him that steel makers had better try to imitate that action. With regard to the electric furnace, he noted that the ferro-manganese was brought to the liquid condition before putting it into the casting ladle. Reference was also made to the employment of the electric furnace for the refining of special steels. Was that likely to lead to the putting down of electric furnaces of higher capacity? The length of the life of the Talbot furnace at Witkowitz was a revelation, and his company had not been able to obtain anything like that length of life for the furnaces at Skinningrove. That was owing to the conditions under which they were operated. In England they had to work with crude iron from the blast furnace without any intermediate mixing. At the September meeting of the Institute in Brussels he had stated that he hoped to have the mixer in operation at Skinningrove in a few months. That hope had not been fulfilled, the second furnace only having been delivered a week ago, and the works had been so pressed for steel that they had had to use both furnaces as finishing furnaces. When the third furnace was available, which he hoped would be in the course of a few weeks, then it was intended to use one furnace as a mixer. With regard to the use of the Talbot furnace as a finishing furnace, that furnace had been bricked up on the casting side to make it entirely solid, so that they would be able in the furnace which Dr. Schuster called a 60-ton furnace to put in 120 tons of metal, to take 60 tons out, and leave 60 tons in, and in that way get the full benefit of the Talbot process throughout.

Mr. Benjamin Head asked whether at Witkowitz they worked the same process in the Wellman furnace as in the small fixed furnace? The meeting would be interested to know that at the Union Works, Dortmund, there had recently been installed some 50-ton tilting furnaces, and the results attained showed an improvement on those given in the paper. The Dortmund furnaces were 10 per cent. smaller than the 60-ton furnace at Witkowitz, and the output had been approximately 250 tons per day from each furnace, whereas at Witkowitz the output was 180 tons. If account were taken of their smaller capacity, and the fact that the Witkowitz furnaces had the advantage of a mixer, the comparative outputs would be 270 tons at Dortmund and 135 tons at Witkowitz. The iron used was practically the same in each case, but the process at Dortmund was presumably different from that at Witkowitz, inasmuch as a development of the Hoesch process was used.

Mr. F. W. Harbord said he had paid a visit to the works at Witkowitz recently, and was able to confirm what had been stated by Dr. Schuster. The open-hearth plant installed there was the most complete of its kind he had ever seen, and included all the adjuncts which made for rapid working. The gas producer plant was also quite the best of its kind that he had had the opportunity of inspecting. With reference to the duplex process, he had always held that there was no excuse for that process except the increase of output. When he was in America last year, he asked why the duplex process was used with the Talbot plant, and the answer was that as the Bessemer plant only cost a small proportion of the capital expenditure in relation to output, it was worth doing, as it enabled makers in times of good trade to increase the output from 30 to 50 per cent., which more than compensated for the loss on capital expenditure when the plant was standing idle during periods of depressed trade. He would like to ask Dr. Schuster if when using the duplex process he desiliconised the metal or whether he blew right down, and what in either case were the costs compared with other processes? With reference to the use of the mixer the result shown in the paper was much better than could be obtained with English iron. Fortunately, Dr. Schuster had a material with a high percentage of manganese, and could desulphurise much more readily. The Union furnace referred to by Mr. Head he had seen in operation. It was really a modification of the Bertrand-Thiel process, and he was told that an output of 200 tons per day from a 60-ton furnace was obtained. That was a high output, and the furnace was certainly worthy the consideration of English steel manufacturers.

Mr. T. Twynam said that the reason for shutting down the Talbot furnace at the Senelle Ironworks in France—a fact referred to in the paper—was that the works were situated in a district where the basic Bessemer process was cheaper, and indeed that process had been adopted with great success.

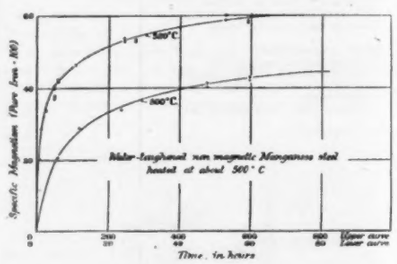
It was announced that owing to want of time, Dr. Schuster would reply to the many points raised in writing.

The President proposed, and the meeting carried with acclamation a hearty vote of thanks to the author for his interesting paper.

Professor Bertram Hopkinson then presented the paper by himself and Sir Robert Hadfield on—

"THE MAGNETIC AND MECHANICAL PROPERTIES OF MANGANESE STEEL."

The present paper is mainly concerned with the well-known alloy of iron with about 12 per cent manganese and 1¼ per cent. carbon, known as "manganese steel." For ordinary commercial use this material is generally heat treated, the treatment consisting in heating to about 1000 deg. Cent. and quenching in water. It is then very tough and strong; a piece ¼in. by ⅜in. section can be bent double without fracture, and the Brinell hardness number is about 200. It was observed by one of the authors many years ago that by heating at a high temperature followed by slow cooling, the material could be made magnetic and very brittle. In a recent paper by the authors some measurements of the magnetism of the steel so treated were recorded, and it was suggested that the important part in the treatment




was probably the speed of cooling rather than the prolonged heating which preceded it. The present research is a further study of this problem.

Pieces of the material as first prepared and water-toughened, which were practically without magnetism, were heated at various temperatures which could be accurately controlled and kept constant, and the results obtained are shown in the diagram below.

Experiments were then tried on the destruction of the magnetic quality which had been induced by the heat treatment just described. It was found that:

(1) Heating the magnetic material at 550 deg. Cent. or at any lower temperature did not diminish the magnetism, which remained about half that of pure iron.

(2) Heating at a temperature exceeding 640 deg. Cent. resulted in diminution of magnetism, the rate of diminution becoming more rapid, and the ultimate value reached becoming less as the temperature rose. The magnetism is almost completely destroyed by a few minutes' heating at 750 deg. Cent.

Effects closely analogous to those which have been described have been observed in a steel containing only a small proportion of manganese.

We take from the paper one diagram which is self-explanatory.

Sir Robert Hadfield pointed out that the research described in the paper had a bearing not only on manganese steel, but on complex problems in connection with other kinds of steel. The authors took specimens of manganese steel in the various stages described in the paper, and determined the carbide carbon. Some very interesting results were obtained. The total carbon dealt with in each case was 1.21 per cent. The carbide carbon was 0.16 per cent. and 0.17 per cent. The specimen was treated at 650 deg. Cent. for six hours, and in the non-magnetic condition the carbide carbon content was then 0.55 per cent. and 0.56 per cent. Another specimen kept at 500 deg. Cent. for six hours, and which had

0.55 per cent. of carbide carbon, had a specific magnetism of 40 per cent. The magnetism of a toughened material which had been subjected to the same treatment, and was then reheated and toughened decreased to practically nil, and the carbide carbon changed to its old percentage of 0.16. This was a remarkable proof of the way in which the carbon content could be changed, and yet these varieties in toughness and hardness obtained, the ball hardness varying between 438 and 200. These were extraordinary anomalies, and the figures suggested that the carbon played no part in connection with the magnetic or non-magnetic condition of the specimen. It would be noted that the same percentages of carbide carbon were given by specimens in which the magnetic properties varied between 0.2 and 40.2. These things suggested how large an amount of research work remained to be done. It was curious that the ball hardness of manganese steel never went beyond a maximum of 550. This point was one of great interest, and suggested a line of research which might solve more than one problem.

Professor H. Le Chatelier, speaking in French, said that the two points more particularly investigated —magnetic properties and brittleness—were points concerning which it was more than ever desirable at the present time to multiply experiments. During the last few years micrography and thermal analysis had considerably added to the knowledge of metals, but it had now become necessary to undertake investigations in other and newer directions. Amongst the properties of metals a few had been almost completely defined by the chemical constitution of the metal. This was the case with regard to density, electrical conductivity, and the thermal phenomena accompanying cooling. Other factors, such, for example, as interstrain, had only an indirect influence on the properties. It was just the opposite, however, with regard to brittleness and magnetic properties. They depended, it was true, on the chemical constitution, but they also depended to a very considerable extent on other factors which it was now found necessary to ascertain and to investigate. Take, for instance, brittleness. A bar of molten zinc was relatively brittle at ordinary temperatures, and thence up to 100 deg. it could not be bent without breaking. At 125 deg., on the other hand, it was impossible to break it. It bent with facility, yet its composition and chemical constitution and structure remained identical. Something else must have undergone a change. Nevertheless, not even microscopic examination of the metal during deformation revealed anything in particular. With regard to the magnetic properties, the facts still remained inexplicable. Take, for example, iron sesqui-oxide. The slightest change in the conditions of its preparation or in its purity or in the temperatures to which it may have been heated would lead to enormous changes in the magnetic properties, although those changes could not be attributed at present to any one of the determining conditions which accompany them. Observations such as those recorded in the paper by Sir Robert Hadfield and Professor Hopkinson appeared to throw much fresh light on the nature of these highly interesting problems.

Dr. Carl Benedicts expressed his interest in the work, which had given them new experimental facts. The rise of magnetic properties was a problem which required to be carefully investigated. An interesting fact was the behaviour of magnetic manganese steel heated at 650 deg. Cent. in comparison with the non-magnetic variety heated at the same temperature. It was pointed out that the final condition at this temperature was different whether it was approached from above or below. That was a point of very great interest. As Professor Le Chatelier had pointed out, many remarkable changes for which no cause could at present be assigned took place in metals. That was particularly the case with the magnetic properties.

Dr. Walter Rosenhain believed it was dangerous to argue back from a research on an isolated alloy steel to what occurred in carbon steels. In order to do that it would be necessary to deal with the subject step by step from high percentages of manganese down to low or vanishing percentages. He had had some specimens of manganese steel supplied by Sir Robert Hadfield for purposes of experiment, and although the research was not yet completed he was able to say that the transformations of manganese steels did not stop at 700 deg. and 400 deg. or 200 deg. Cent. He had succeeded in getting points in the cooling curve as low as 50 deg. Cent., and had obtained points in another case at 25 deg., and 255 deg. and 155 deg. Cent. It was evident that there was quite a number of transformation points where heat was evolved at exceedingly low temperatures, compared with anything that had been noted in the case of carbon steels. There had been no opportunity up to the present time to correlate these results with hardness, magnetic properties or the microscopic structure, but he hoped to deal with the subject more fully at a later date.

Dr. J E. Stead referred to the laborious character of the work in a research where specimens had been heated for 800 hours. He would like to ask one question, and that was what was meant by the statement "after heating for six hours at 400 deg. Cent., the surface became covered with interlacing lines. Those lines represented plates of hard material, the edges of which, it was stated, were left standing up by the polishing. What he wished to know was, did these lines rise out of the surface during the heating?

Professor Hopkinson said the specimen was heated and polished after heating; there were no elevations on the surface after simple heating.

Mr. W. H. Hatfield believed that the whole of the facts set forth in the paper would be found to be well included in the solution theory when viewed by the light of modern chemical knowledge.

Professor Hopkinson expressed his interest in the research which was being carried out by Dr. Rosenhain. One point of considerable importance referred to the effect of over-straining on manganese steel. His own experience went to show that the effect of breaking a bar was to make it very slightly magnetic as well as hard. The effects produced were, indeed, much the same as those which followed prolonged heating at 300 deg. to 400 deg. Cent. One other point was the relation between the amount of magnetism present in the test piece and the absorption of heat. He did not carry out these tests, but he believed he was right in saying that they were all carried out on material which had been made as magnetic as it could be made. It would be rather difficult by that method to arrive at a quantitative relation between the amount of magnetism and the amount of heat absorbed.

Sir Robert Hadfield said that Mr. Hatfield had raised an interesting question, but he would like to point out that the conditions under which the work was carried out made it quite certain that the magnetic results were absolutely pure physical changes, and had nothing to do with grinding or decarburisation or anything of that kind. The results obtained represented absolutely new and novel conditions.

The President, in moving a vote of thanks to the authors, expressed the pleasure of the meeting at the presence of their eminent French colleague, Professor H. Le Chatelier.

Two papers—one by Mr. C. A. Edwards and Dr. H. C. H. Carpenter, and the other by Mr. A. McCance, formed the subject of a joint discussion. The first is entitled,

"THE HARDENING OF METALS, WITH SPECIAL REFERENCE TO IRON AND ITS ALLOYS,"

and is a very long paper, but the authors thoughtfully have provided a summary, which we give here:—

The foregoing pages may be conveniently subdivided into three sections, which deal with subjects that are in many ways related to each other, but which may be considered quite separately. These are:—

(1) The mechanism of annealing.
(2) The hardening of metals by quenching.
(3) The constitution of austenite and martensite.

*The Mechanism of Annealing.*—In regard to the annealing or softening of metals by heating them to moderately high temperatures, followed by slow cooling, we conclude that this operation consists in promoting the growth of the crystals. The softening of the mass which is brought about in this way is due to the gradual elimination of the hard amorphous material which exists as envelopes around the crystals, and not to any change in the nature or hardness of the crystals themselves. The growth of crystals is in all probability caused by the unstable nature of the amorphous material, which tends to recrystallise. This recrystallisation increases as the temperature is raised, and must proceed by the gradual growth of certain crystals at the expense of others. During this process the amorphous envelopes act like ordinary electrolytes, whereby the substance of one crystal is transposed to another.

*Hardening by Quenching.*—In the operation of quenching such alloys as carbon steels, severe stresses are set up which cause very pronounced crystal twinning. This twinning appears to be directly connected with the intensity of the thermal changes that occur when the mass is slowly cooled, and particularly with the carbide of $Ar_1$ inversion. The increased hardness which is produced by quenching steels from temperatures above their highest critical point is directly related to the velocity and thermal magnitude of the suppressed inversion, and the connection between these factors, crystal twinning and carbon percentage, is very evident. At all the surfaces of slip upon which twinning occurs amorphous layers are formed which are similar to those that Dr. Beilby has shown are produced when metals are deformed and hardened by cold working. We consider that the ultimate cause of hardening by quenching steels is due to the presence of these amorphous layers. It thus follows that the final cause of hardening by quenching is exactly the same as that of hardening by cold working, viz., the internal deformation of the crystals. The means by which this is brought about is, however, somewhat different. In the case of the so-called austenitic steels, the special elements present give rise to the formation of new compounds, which, no doubt, owing to their molecular weight, exert a greater osmotic pressure when in the $\gamma$-iron solid solution, and lower the temperature at which the carbon separates from solution. They also decrease the velocity of the carbide change. The action is such that rapid quenching is not necessary in order to preserve the mass in the same physico-chemical constitution as properly quenched carbon steels. In both cases the carbide change is inhibited by pressure, but when this is brought about by external means such as quenching, twinning of the crystals is produced, whereas when the whole of the necessary pressure is already inherent in the mass, as osmotic pressure, no internal crystalline disturbance occurs. The amount of twinning which is produced by quenching is proportional to the amount of the inversion which has to be suppressed by external means, or inversely proportional to the retarding influence of the special elements present. Hence twinning is entirely absent when the necessary internal pressure is sufficient, as when the required amount of nickel is contained in the steel. We consider that these conclusions are in accordance with all known experimental data which have a bearing upon this particular phenomenon, and, further, they do not appear to totally exclude any theory which has been previously formulated. Indeed, we cannot refrain from saying that when carefully and impartially considered, each of those theories has some special merit, and it is sometimes a very difficult matter to decide at what stage one begins and another ends. In this connection, however, it is interesting to note that most of the important points of previous theories are in some form or another included in the above conclusions.

*Constitution of Martensite and Austenite.*—Further evidence is given in the last section of this paper in support of the suggestion, previously made by one of us, that there is no constitutional difference between these two constituents, and that the apparent difference is due to twinning. Whilst we have not yet been able to experimentally prove this view, we are not aware of any fact which indicates the contrary. Moreover, in certain quenched copper-aluminium alloys, which are in every respect analogous to the cabon steels in which these so-called constituents are found, the effect has been conclusively proved to be due to crystal twinning.

The second paper was even longer than the former, and we give only the conclusions. It is entitled,

"A CONTRIBUTION TO THE THEORY OF HARDENING."

1.—The cooling curve of a cylindrical rod during quenching follows closely the cooling curve calculated on the assumptions that the surface of the rod is at the boiling temperature after immersion in the water, and that the cooling takes place according to the mathematical theory of conduction for this condition.

2.—During the quenching of steel two transformations can take place—(*a*) the transformation of $\gamma$ to $\alpha$-iron; (*b*) the transformation of carbon in solution to the state of carbon out of solution. The first of these can take place independently of the second, but the carbon cannot change its condition without necessitating the transformation to $\alpha$-iron of the $\gamma$-iron in which it is dissolved.

3.—$\beta$-iron is not a separate allotropic condition of iron, but is only $\alpha$-iron which has lost its ferro-magnetism due to purely thermal causes—causes which are operative in every substance when heated. The thermal disturbances at the $A_2$ point are due to the variation in specific heat following the loss of ferro-magnetism.

4.—On quenching steel the amount of carbon retained in solution is proportional to the cooling velocity at the $Ar_1$—or at a temperature a little below this—and there is a minimum velocity of cooling which must be attained to keep all the carbon in solution.

5.—The change from $\gamma$ to $\alpha$-iron takes place with a very high velocity of transformation, and no cooling which can be obtained under practical conditions is sufficiently fast to appreciably retard it. This velocity of transformation is lowered by the solution of other elements in the iron.

6.—In a quenched and uniformly hardened steel the carbon is in the state of solution, and it retains a portion of the iron in the $\gamma$ condition—the proportion increases very rapidly with the carbon content. The majority of the iron is, however, in the $\alpha$ condition, but owing to the restricted mobility during the period of quenching, the crystalline units are not homogeneously orientated, and the hardness of quenched steels is due to this condition, which is similar to that of "inter-strain." The hardness is inter-strain hardness.

7.—Cracks may be formed during quenching through two causes—(*a*) by stresses due to differences in temperature causing differences in expansion; (*b*) by differences in expansion caused by non-uniform hardening—that is, by differences in cooling velocity. Definite modes of cracking are produced by each of these causes, which can be recognised.

The investigations recorded in this paper all relate to the quenching temperature in its relation to the $Ac_1$ point, and they are being continued on the same steels with the temperature of quenching viewed from the $Ar_1$ point as a basis. This will bring the practical more in accord with the theoretical conditions. Later it is hoped to examine in a similar manner the effects of tempering on the physical properties, and to interpret the results in the light of the above theory.

Dr. G. T. Beilby said the first paper was a bold attempt to grapple with the hardening problem, a subject to which he had himself devoted a good deal of attention. A point which was vital to the whole significance of the theory put forward was the question why the vitreous amorphous phase should be harder than the crystalline. It was interesting to consider how hardness, or the power to resist deforming stresses without permanent deformation, might be affected by the molecular structure of the metal. In a mass of metal there was a certain available amount of cohesion which was the product of the specific cohesion of each molecule by the number of molecules present, and the rigidity of the aggregate which meant its hardness would be determined by the use to which the available cohesion was utilised in the structure of the aggregate. He was acquainted with no evidence that changes in rigidity and elasticity occurred in hardened and tempered steel which was kept at ordinary temperatures.

Dr. Walter Rosenhain was of opinion that there was no foundation for the theory that quenched steel was hardened by strains occurring during sudden cooling. The movements were not large enough. Nothing like serious hardening was obtained until the metal had been stretched or strained very considerably, and in a piece of steel which was being quenched the actual amount of movement which took place was so slight that it was impossible to ascribe to it any disturbance of the molecular arrangement.

Mr. D. Carnegie referred to a point of practical interest arriving out of the curves which were included in the paper by Mr. McCance. These brought out the important fact that the Brinell hardness of 713 occurred in the specimens containing .069 and .06 carbon.

Sir William Beardmore dealt with Mr. McCance's paper. The theory put forward was that the hardening was due in the first place to the carbon being dissolved in the gamma iron at the $Ac_3$ point. Secondly, that at the $Ac_2$ point the remaining iron changed into the gamma condition, and that on quick cooling the carbon remained in the hardened condition diffused throughout the mass, the greater part changing to the alpha condition, but a part of the iron being retained in the gamma condition. To bring that theory into line with workshop practice it was necessary to shed that part of the theory which suggested gamma iron being retained in the steel after cooling. The whole theory of hardening depended upon carbon condition and inter-strain. That theory of inter-strain brought the hardening of steel into line with the hardness produced by cold working such as shearing, wire-drawing, and other shop operations.

Sir Robert Hadfield said that the theory put forward by Mr. McCance had been advanced many years ago by two eminent American workers, Professor Langley and Mr. William Metcalfe, who in a paper written in 1892 had suggested that a true hardening effect

# HYDRO-ELECTRIC POWER PLANT ON THE MISSISSIPPI

(*For description see opposite page*)

Fig. 20—FOREBAY SIDE OF THE POWER HOUSE

Fig. 21—TAIL RACE AND OUTLETS FROM DRAUGHT TUBES

Fig. 22—THE GENERATOR ROOM

Fig. 23—DISCONNECTING SWITCHES ON 110,000 VOLT LINE

might be obtained by the tension which could be set up by quenching from the heat of boiling water to cold water. If steel could be hardened in the way suggested, the sooner the industry had experimental proof of the fact the better, and if Dr. Rosenhain, who had the very delicate apparatus necessary at his command, would carry out a practical research on the subject he would earn the thanks of all members.

A vote of thanks having been accorded to the authors of the papers, the conference adjourned until the following day.

The annual dinner was held on the evening of May 7th, when Monsieur Adolph Greiner presided over a distinguished company, which included the Belgian Minister and the President of the American Iron and Steel Institute.

## 300,000-HORSE-POWER HYDRO-ELECTRIC PLANT ON THE MISSISSIPPI.

No. III.*

THE power-house proper is a structure built upon the enormous mass of concrete already described, this mass being 1720ft. long, 132ft. wide, and 60ft. high. The building is 120ft. wide, and has steel columns and roof trusses, with walls of brick and concrete. The interior has a clear height of 60ft. from the floor to the roof trusses. It is divided longitudinally by a concrete wall, forming a room 65ft. wide on the river side for the generators and electrical apparatus, and a room 40ft. wide on the forebay side which covers the intake chamber and provides for handling the gates, screens, and trash racks. At present the building is erected for only 900ft., about half its ultimate length, but the foundation portion is complete for the full length of 1720ft. A plan of part of the building is shown in Fig. 24.

Fig. 20, page 530, is a view of the power-house from the forebay side. The superstructure is completed for only half the ultimate length, and the substructure extends beyond it. The arches indicate the openings to the wheel pits. The curved structure at the left is the concrete fender pier, extending from the main dam to the shore. The openings of this are normally submerged, so as to exclude ice and drift wood, logs, &c. The generator-room is 50ft. wide, and at its rear is a row of compartments 15ft. deep—against the partition wall—in which are placed the transformers, high-tension apparatus, and the exciter sets. On the upper floor are the high and low-tension oil switches and buses, andl the ightning arresters. There are two 150-ton electric overhead travelling cranes in the generator room, and a similar 75-ton crane serves the gate-room.

The power equipment will eventually comprise thirty vertical shaft Francis reaction turbines, each developing 10,000 horse-power at the normal working head of 32ft. The actual head may range from 20ft. to 40ft., at which the power of the turbines will be 6000 and 14,000 horse-power respectively. Each turbine drives an alternating-current generator of 7500 kilovolt-ampère capacity, 33ft. diameter, and 11ft. high. These generate three-phase 25-cycle current at 11,000 volts. The total revolving weight of the turbine and generator is about 275 tons, and the normal speed is 57.7 revolutions per minute. The thirty generators will be served by four exciter units. At present the plant comprises fifteen generating units and two exciter units. Ten of these generating units were in operation in July, 1913.

The conditions under which the station works necessitated the use of very large machines, and the reaction type of turbine was adopted for the reasons that it operates with full buckets, that it can be set low enough to utilise the full head at all times—and thus have the highest speed due to the head—and that it will operate efficiently when fully submerged. It has also a high degree of speed regulation. While double runner turbines have been used in some cases, those at Keokuk are of the single runner type, on account of the less trouble they give in operation, in maintenance, and in lubrication. This is the first large American plant having low-speed machines connected directly to single runner turbines. With the double runner type a higher speed of rotation might have been obtained, with advantage to the electrical machinery, but the controlling mechanism would have been more complicated and less accessible. On test the turbines have shown an efficiency of 86 to 88 per cent. Their overload capacity is 13,000 horse-power. Foreign designs for these great turbines were submitted by Swiss, French, German, Italian, and Norwegian engineers, but the designs of American engineers were found to meet the particular requirements to best advantage. The design finally adopted—including the delivery tubes and draught tubes—was prepared by a committee composed of the chief engineer and mechanical engineer of the power company and the chief engineers of the two American manufacturing companies between which the contract for the first fifteen turbines was divided—the Wellman, Seaver, Morgan Company, of Cleveland, and the I. P. Morris Company, of Philadelphia.

According to a description in the American *Engineering News*, the essential differences between American and European types of reaction turbines are in the shape and dimensions of the buckets. In turbines of this type the aim is to secure in the runner or rotating member a combination of the largest possible discharge capacity with the smallest possible diameter, as this results in the minimum weight of metal to utilise the maximum percentage of the available reactionary force and to obtain the highest speed. Decreasing the diameter increases the velocity, the head being constant, but it decreases the discharge capacity. In the American type of runner a large discharge capacity is secured by the shape of the buckets and the axial depth of the entry passages. These passages are made as large as possible by making the vertical sections of the vanes deeper instead of by increasing the diameter, while the outflow sections are enlarged by the broad dishing of these vanes. In this way the runner is given extremely large entry and outflow areas in proportion to its diameter, while the curvature of the vanes is such as to utilise the greatest amount of reaction force. The vanes are of cast steel, with hollow forged steel stems fitted to bronze bearings in the upper and lower rings of the casing. These are lubricated with grease.

In the Keokuk turbines, the runner comprises the hub and twenty radial buckets, and is 16ft. diameter and 12ft. high. One of the makers made each runner a single casting weighing 67 tons, but had to build a special steel platform wagon for transporting it by rail, the floor being cut away to let the larger "mushroom" end extend nearly to the level of the rails. The other maker cast each runner in four pieces, with an aggregate weight of 95 tons. One of these great runners is shown in Fig. 25.

The runner is carried by a 25in. vertical shaft, 25ft. long, coupled to the generator shaft. There is a single thrust bearing below the generator bearing, supported by a conical spider frame seated in the wall of the wheel pit. Near the lower end of the shaft is a steady bearing.

Fig. 27 is a vertical section through one turbine. In the thrust bearing oil at 250 lb. pressure is forced between a broad flat stationary ring and a similar rotating ring on the shaft, so that the weight of the revolving parts is carried on a film of oil. To provide

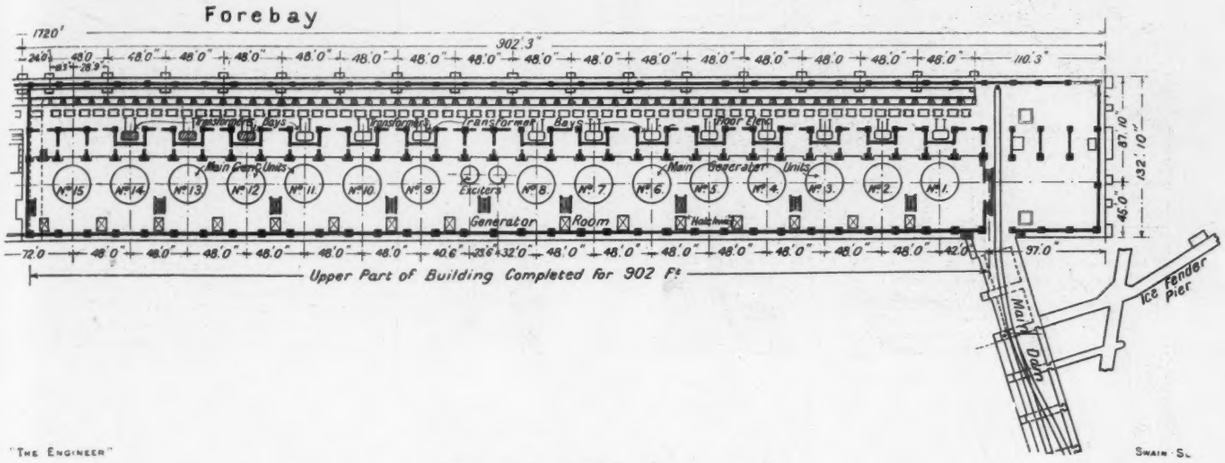



Fig. 24—PART OF POWER-HOUSE COMPLETED

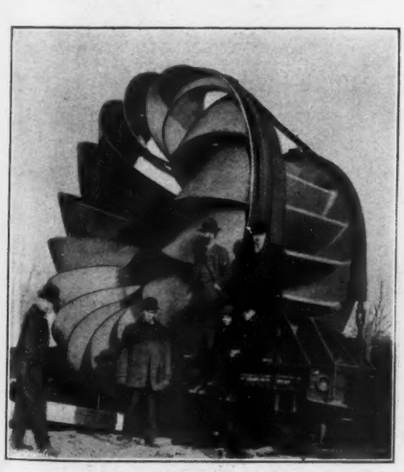


Fig. 25—RUNNER FOR 10,000-H.P. TURBINE

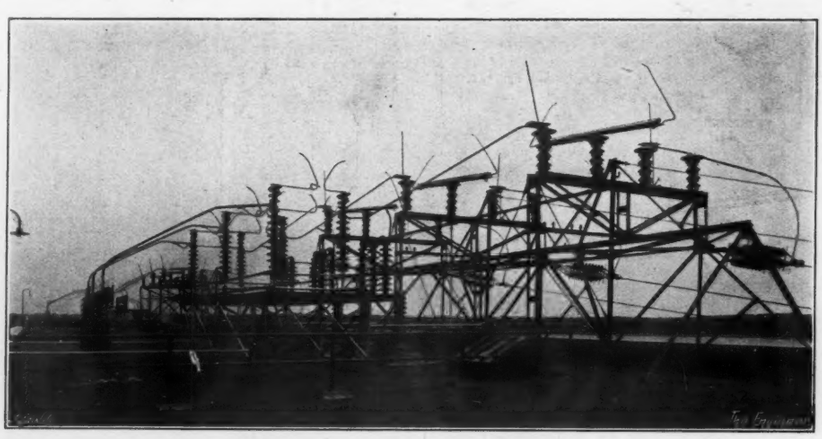


Fig. 26—ROOF STRUCTURE FOR 110,000-VOLT TRANSMISSION LINE

* No. II. appeared May 8th.

against accident consequent upon any failure of the oil supply, a roller bearing is fitted between the two rings. As the oil in the bearing cannot escape, the loss of oil pressure would simply lower the revolving ring upon the rollers, which would constitute a roller bearing running in oil. This would carry the load until the normal pressure could be restored. The oil supply is in duplicate, a motor-driven pump going into action automatically in the event of the pressure from the shaft-driven pump being reduced. For three of the units the Kingsbury thrust bearing is being used, which requires oil at atmospheric pressure only.

While the position and the use of these single thrust bearings is simple and convenient, an even simpler arrangement has been used in some machines of the same size for a Canadian hydro-electric plant. In that case the thrust bearing is arranged upon the top of the shaft above the generator.

The turbine, with its shaft and bearings, is mounted in a steel-lined well or pit, 21ft. diameter, formed in the solid concrete mass of the power-house base—Fig. 23. There is a floor at the thrust bearing level, and inspection holes in the housing enable the bearings to be regularly watched and inspected. Access to this floor is by steps from a basement or tunnel running the full length of the outer side of the power-house and having chambers also for the triplex oil pumps, accumulators, and receiver tanks which serve the thrust bearings. For each unit there are two pumps, one driven by chain gear from a horizontal shaft which is driven from a bevel gear on the turbine shaft, and the other pump driven by an induction motor. The latter is controlled by a pressure system and is started only when the oil supply or pressure begins to drop.

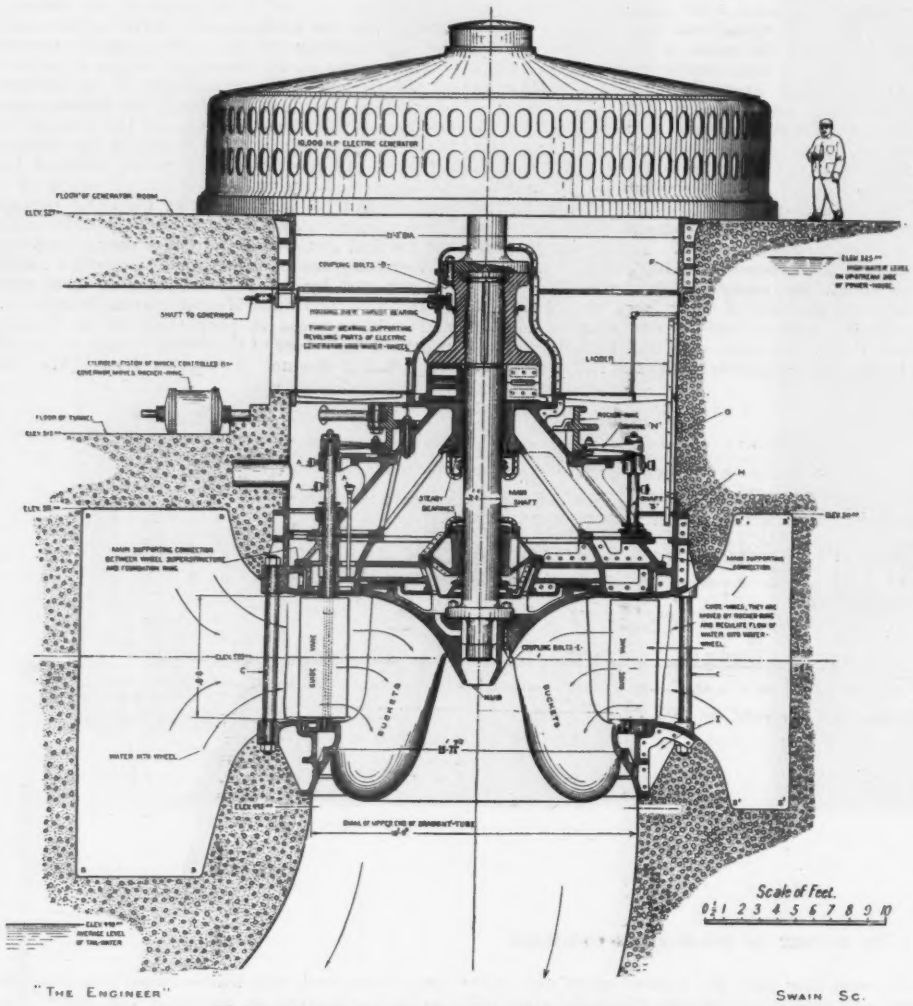



Fig. 27—SECTION THROUGH 10,000-H.P. TURBINE

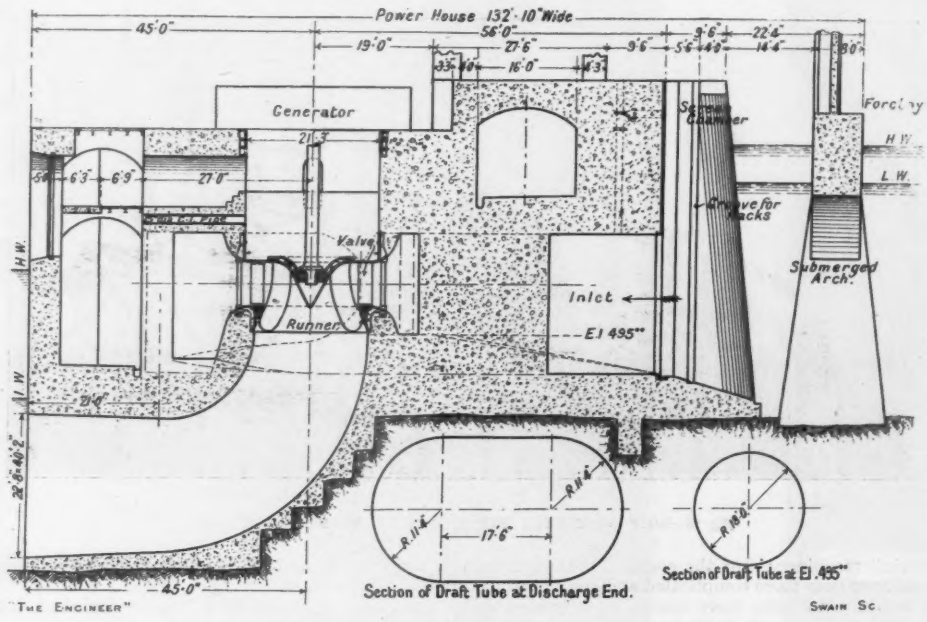



Fig. 28—CROSS-SECTION OF SUBSTRUCTURE OF POWER HOUSE

From the forebay there are four inlets 7½ft. by 22ft. for each turbine, as shown in the section, Fig. 28. One of these leads almost directly to the wheel, while the others are curved to unite in a scroll chamber 39ft. diameter, which surrounds the remainder of the circumference, so that the wheel receives the water throughout its entire periphery. The scroll chamber—Fig. 29—is formed by a spiral curve, so that the width is constantly diminishing. In this way there is a uniform rate of flow through the guide vanes in the casing which surrounds the revolving runner. Regulation of the water supply in accordance with the load is effected by the automatic movement of these vanes under the control of the governor.

The draught tube beneath the runner is 18ft. diameter, giving ample discharge capacity for all water that can enter, and giving a flow velocity of 14ft. per second. The passage enlarges and turns to a horizontal direction at the outlet, which is 22½ft. high and by 40ft. wide with rounded sides, so that at the outlet the velocity is reduced to about 4ft. per second. The bottom of the outlet opening is level with the floor of the tail race, which is a channel excavated in the river bed along the side of the power-house to a depth of 23ft. below the river bed. Fig. 21, page 530, shows the tail race excavation, with the power-house and the draught tube outlets at the left. At the right is the cofferdam built upon the river bed, 23ft. above the floor of the tail race, and on this cofferdam is standing a construction train for some strengthening work on the cofferdam. Between the train and the power-house may be seen the arches of the west end of the main dam.

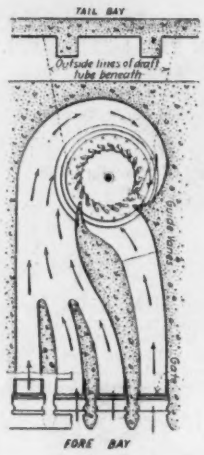



Fig. 29—PLAN OF SCROLL CHAMBER

The governors which regulate the water supply in accordance with the load—by shifting the guide vanes around the turbine wheel—are of the Lombard oil pressure type. On the power-house floor is the main part of the governor, containing the speed control element and anti-racing apparatus; these operate sensitive valves, which in turn operate the large balanced relay valves, and thus operate the oil pressure cylinders, which are arranged in the basement or tunnel. The governor can be converted from automatic to hand operation, the gates then being capable of being moved to any position from closed to full open without regard to the speed of the runner. An interior view of the generator room is given in Fig. 22, page 530. It shows the governor stand in front of each alternator.

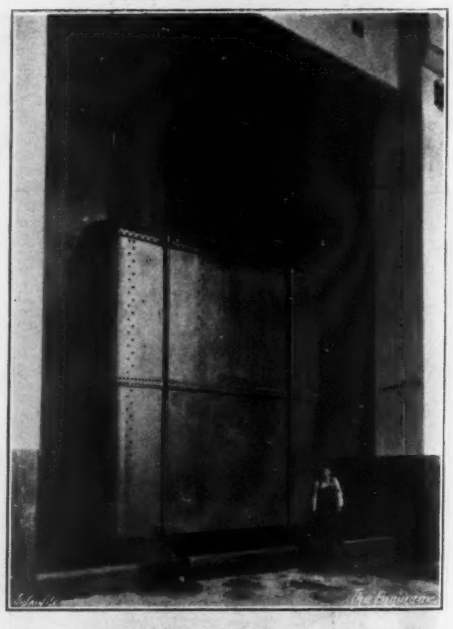


Fig. 30—TRANSFORMER

The exciting current for the main alternators is generated as alternating current by auxiliary turbines of 2000 horse-power, and is distributed to motor-driven exciter generators, one for each alternator. Each main unit is regulated by adjusting the field of its exciter. This arrangement eliminates large field rheostats and energy losses. The reactance of the

generators and transformers is high enough to protect individual units, but special reactance coils are used in the tie links between bus sections of groups of four generators to break the generator bus into sections of 28,000 kilowatts in case of heavy discharge to a fault. The slow speed of the alternators made it practicable to provide considerable reactance in their windings, and the transformers are wound for reactance of 5.7 per cent.

room and the generator room. Current for operating the oil switches and for general switch-room service is supplied from two storage batteries, each of 320 ampère-hour capacity, for charging which there are two motor generator sets of 15 kilowatts. Fig. 32 is a view of the chief operator's room at the power-house.

Four of the main units supply the current which is transmitted to the electric company at St. Louis

of eighteen miles there are watchmen's houses.

The six conductors are nineteen-strand copper cables about 0·63in. diameter with a cross-sectional area of 300,000 circular mills. The ultimate strength is 14,000 lb., while with a ½in. coating of ice and a wind velocity of sixty miles an hour at zero temperature the load would not exceed 7000 lb. Each cable is carried from the end of a steel cross arm by a suspension insulator 4ft. long, consisting of seven porce-

Fig. 31—LOW-TENSION BUS ROOM

Fig. 32—MAIN SWITCH ROOM AT POWER STATION

For the exciting of the present fifteen main units there are two auxiliary alternator sets of 1600 kilowatts, of the same type and arrangement as the main units, but running at 125 revolutions. These furnish 440-volt 25-cycle current for operating the individual motor generator exciters of the several main units. Each of the two alternator exciters has its own direct-current exciter mounted on the shaft extension above the alternator, so that it can be started as a self-contained unit.

In view of the great length of the building, the distribution of the exciting energy as alternating current effects an economy over the direct-current distribution system more generally employed. As an alternative the motor generator sets can be operated also with 440-volt 25-cycle current taken from the main 11,000-volt bus through transformers. Further, in emergency these sets can be operated from the storage batteries used in connection with the operation of the oil switches in the switchboard room.

The exciter fields of all the main alternators are controlled by Tirrell regulators, the parallel operation of which is effected by means of series transformers interposed in the machine leads, so that exchange currents between these alternators are compensated automatically.

Opposite each main alternator is a concrete cell or chamber containing its high-tension transformer of 9000 kilovolt-ampère. This is a three-phase transformer unit, stepping up the current from the 11,000-volt generator pressure to the 110,000 volts for the transmission lines. The transformer is 8ft. by 16ft. in plan, and about 25ft. high to the top of the bushing; its weight is 125 tons, including the core and the oil. It is mounted on small wheels, so that when disconnected it can be run under the travelling crane to be removed for repair or dismantling. In case of fire, a trip valve in the 6in. oil discharge line can be opened, and the oil discharged rapidly into the river. One of these transformers is shown in Fig. 30. Fig. 31 is a view in the low-tension bus room, and Fig. 23, page 530, shows a set of disconnecting switches for the transmission line.

From the transformers the 110,000-volt leads are carried up through concrete shafts to the high-tension oil switches connecting to the duplicate buses. These switches are of the solenoid non-automatic type. The high-tension circuits pass through the roof in vertical porcelain bushings 12ft. long. Choke coils are inserted in each phase wire just below the lightning arresters. On the roof structure, shown in Fig. 26, are mounted air break switches to disconnect entirely the transmission lines from the apparatus in the building. These have pivoted arms, 12ft. long, ending in vertical horn gap members. The three switches of each circuit are operated by a single lever, and when these switches are opened earth connections are applied to the line wires by raising earthed switch arms. For each circuit there is a group of four lightning arresters of the aluminium cell type, three connected in star to the phase wires and the fourth forming an earth connection to the neutral point thus established.

The switchboard equipment is mounted in a room at the south end of the present building, so that it will be in the middle of the completed plant. The switchboard is of the remote control type, divided into sections. The bus connections are indicated by diagrams on the bench boards, and coloured pilot lights show the position of the switches. Opening from the switchboard room is an inspection gallery overlooking the generator room. The switchboard room is well equipped with a telephone system to various parts of the power-house and sub-stations, and has also a system of signals for orders between this

for tramway, lighting, and power purposes. The 11,000-volt current from the generators is stepped up to 110,000-volt by the transformers for this transmission over a distance of over 140 miles. The transmission line consists of twin circuits carried in parallel vertical planes on four-sided steel towers about 80ft. high, each with three steel cross arms 10ft. apart. Every tenth tower is an anchor tower, designed to withstand a dead-end side pull of 50,000 lb. Anchor towers are used also at railway crossings.

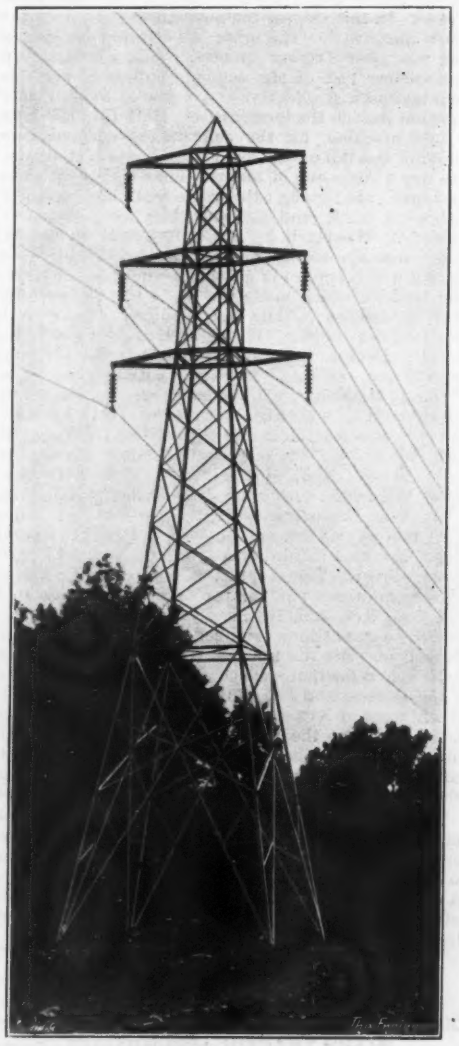


Fig. 33—TRANSMISSION LINE TOWER

The transmission line is built along one side of a private strip of land 100ft. wide, leaving room for a second line in the future. Paralleling it, on wooden poles set on the boundary line of the land, is a telephone line. This is carefully insulated, and a guard wire protects it against lightning and transmission line induction disturbances. Telephone booths are placed at intervals of four miles, while at intervals

lain discs 10in. diameter. These have withstood tests up to 440,000 volts dry and 330,000 volts when wet. At the anchor towers the end of each cable is attached to a similar strain or anchor insulator, which is horizontal, the two cables being connected by a loop cable or jumper. Along the tops of the towers is strung a ¼in. guard wire of galvanised steel.

The normal span is 800ft. between towers, and the ordinary towers, weighing 3½ tons each, are designed to resist the unbalanced pull which may be exerted by two broken conductors, in addition to the weight and strain of all the conductors under extreme conditions of weather. One of these towers ie shown in Fig. 33. The anchor towers weigh 5 tons each and are designed to stand a dead-end side pull of 50,000 lb. The four legs of each tower rest on reinforced concrete pedestals or footings, those for the anchor towers being 7ft. deep and weighing 7½ tons each. The top of the concrete is just above the surface of the ground.

The transmission line begins, however, by a span of 2800ft. crossing the Mississippi River. One end of this is carried by the high-tension structure on the roof of the power-house, while the other end is carried by a pair of strain or anchor towers 135ft. high. Farther down the line again crosses this river and then the Missouri River. Each of these crossings has a pair of towers at each end, but they are not anchor towers, and in one place the towers are 230ft. high.

The conductors for these long span river crossings are of the same size as the others, but with a covering of twenty copper strand wires, which increases the diameter to 0·875in. They are all in the same horizontal plane and spaced 20ft. apart, so as to eliminate all danger of contact by swinging in high winds. For each circuit there is a ⅜in. steel ground cable, these cables being strung above the conductors and having hangers to carry the telephone wires. On these cables also run the trolleys from which the inspection cars are suspended.

At St. Louis this transmission line enters a brick sub-station of 60,000-kilowatts capacity, which is said to be the largest in the world. It is T-shaped in plan, with the high-tension equipment in the stem and the apparatus for the electric light, power, and tramway companies in the end portion. It is 220ft. long and 150ft. wide across the end, with a height of about 65ft. On the roof of the stem portion of the building is a steel frame carrying the high-tension wires, which drop from the frame to vertical inlet bushings in the concrete roof. On the roof also are four motor-operated air-break disconnecting switches and the horn gaps of the lightning arresters.

The equipment is divided into four high-tension units, two for the tramways and two for the light and power service. These can be used interchangeably, and each is capable of taking care of the 66,000 horse-power maximum load, so that line repairs, &c., can be made without any interference with the service. In the gallery of the high-tension section are four groups of oil switches—with three switches to a group—placed between the incoming 110,000-volt lines and the high-tension buses, which are of 1in. copper tube and are divided into four sections by oil switches. On the ground floor are four groups of transformer switches and three groups of bus switches, each group consisting of three single-pole oil switches. The switches open by gravity and are closed by solenoids with remote control from a storage battery. Above these groups of switches are disconnecting switches to isolate them from the high-tension buses in case of repair work.

The transformer room has four compartments, one for each unit, each containing three 110,000–13,800-volt water-cooled transformers of 5000 kilowatts.

These are mounted on wheeled trucks, and by raising a steel rolling curtain which forms one side of the compartment they can be run out under the travelling crane for the removal of the core or making repairs. The core weighs 30 tons, and with 5000 gallons of oil in the tank each transformer weighs about 55 tons. The oil filter press can purify about 600 gallons of oil per hour.

The four distributing panels in the sub-station have five circuits each, some of which are led out to overhead lines and others to underground cables running to sub-stations in different parts of the city. A certain proportion of the current, however, will be transformed to lower voltage or converted to direct current for distribution from this station. For this purpose there will be for the light and power company's service two 25–60-cycle frequency changers of 5000 kilowatts, and a group of 13,200–4400-volt 60-cycle transformers aggregating 9000 kilowatts. Similarly, for the tramways company's service there will be at this station four 375–600-volt rotary converters of 2000 kilowatts, with air-blast transformers for stepping the pressure down from 13,200 volts to 375 volts.

The station is protected by four sets of aluminium cell lightning arresters of the grounded tank type, there being one to each 100,000-volt high-tension unit. These are situated in the gallery of the high-tension room, with their horn gaps above the roof.

One of the objects of the enterprise is to develop the city of Keokuk as a centre for large manufacturing enterprises, thus creating a field for the local utilisation of current on a large scale. At present, however, the largest part of the business is the supply of 66,000 horse-power to St. Louis, as described above. A branch from this transmission will run to the city of Alton, which is the centre of an extensive coal mining and manufacturing district forming a large field for the introduction of electricity. Another transmission line extends northward up the river from Keokuk to Burlington, a distance of 40 miles. This carries current at 11,000 volts. The company has a contract to supply current for tramway, lighting, and power purposes to the Keokuk Electric Company, a local subsidiary concern. It has also a contract to supply 10,000 horse-power to the Atlas Portland cement works at Hull. Another contract, which is likely to increase in importance, is to supply 2000 horse-power to the Central Illinois Public Utilities Company, which has a chain of steam power stations and 700 miles of transmission lines serving about 125 cities, towns, and villages. This company's business includes the supply of current for tramways, electric railways, waterworks, and drainage pumps, city lighting, light and power for mines, &c.

But with generating plant of 150,000 horse-power already installed, and plant for 150,000 horse-power additional yet to be installed, one of the most important lines of work of the Mississippi River Power Company is to develop the field for the utilisation of its available current, both adjacent to its main hydro-electric generating station and along the routes of its transmission lines.

## MOTOR VEHICLES FOR WAR PURPOSES.

MORE than the usual amount of interest attaches to the road tests of commercial motor vehicles which are now being carried out by the War-office authorities on account of the fact that this is the first occasion, we believe, on which the worm-driven live axle has been submitted to the tests necessary to earn the Government subsidy. It will be remembered that the British Government some time ago decided upon a subsidy scheme for petrol-driven motor lorries for use by the War Department "in case of national emergency." The details of the scheme are briefly as follows:—The purchasers of vehicles of types which have passed War Department Trials can obtain a subsidy of £110, £30 of which are paid to the owner when the machine is enrolled, and the remaining £80 are payable in six half-yearly instalments. Two classes of lorries are accepted, one to carry 3 tons useful load and the other to carry 30 cwt. useful load. The advantages which accrue to the owner of subsidised vehicles, in addition to the sum above mentioned, are several. First, the purchaser ensures obtaining a machine of a type which has undergone severe official tests of a run of at least 1500 miles over difficult roads; secondly, he is assured that the design has been carefully thought out and submitted to Government inspection, economy as regards the consumption of spirit being required; thirdly, the subsidised vehicles are fitted with larger wheels than is customary, which give smooth and satisfactory running. In the event of a "national emergency" the War-office has the right to purchase such vehicles at fixed prices, payment being made immediately the vehicle is handed over without there being any necessity for arbitration or assessment of value.

Perhaps the chief desideratum for vehicles for War-office purposes is standardisation with regard to such features as gear-changing mechanism and control, for the machines must be so similar in these respects that drivers can change over from one vehicle to another, even in the dark, and be capable of handling either with equal success. Another requisite feature is ample road clearance to enable the machines to traverse rough country, and, if necessary, pass through streams as deep as 18in. They must also be limited in tare weight to allow them to pass over bridges and have ample protection above in case of bad weather and below from damage due to dirt. With the latter object the whole of the engine and gear box is protected by an undershield, which is easily removable when necessary. Moreover, the machines must be fitted with a gear low enough to enable the vehicle to carry its load unaided up the steepest hills likely to be met with, whilst the transmission must be such that speeds as high as 16 miles an hour can be obtained on the level, and the petrol consumption must not exceed 50 ton-miles gross per gallon.

Although neither chain nor worm gearing for the final transmission to the road wheels has so far met with favour at the War-office, there are numerous makers who are prepared to build machines to comply with the Government's drastic requirements. These include Leyland Motors, Limited, Thornycrofts, Wolseleys, Walker Brothers, Claytons and Huddersfield—all of whom fit bevel driven axles.

Several machines built in accordance with this scheme are now undergoing strenuous tests on the public roads, and our representative was permitted to accompany the machines on a run of nearly 100 miles on Tuesday last. The machines were all of the Class A type to carry 3 tons, with the exception of one, and were loaded up to 4½ tons net. They left Woolwich at 8 a.m., and throughout the day's run traversed some of the hilliest districts in Kent. The route taken was *viâ* Dartford, Gravesend, Rochester, Sandling, Boxley, Bearstead, Hollingbourne, Maidstone, Mereworth, Trottiscliffe, Wrotham, Farningham, Sidcup and Eltham back to Woolwich. The actual distance covered was 88 miles, and careful records of the machines' running were kept by Government officials. Two especially stiff hills were selected for testing the climbing capabilities of the vehicles. The first was Boxley Hill, a long, stiff gradient with a crowning stretch of about 100 yards of 1 in 6. The machines were sent up this first, and all reached the summit by the aid of their lowest gears without any signs of overheating such as would have shown themselves two or three years ago. They were then turned round and run down the hill to test their brakes. In this respect the machines behaved on the whole quite well. The other hill selected for special test was near Trosley Towers. This was an even more severe test of the engine's pulling powers, as the maximum gradient of 1 in 6 was of much longer duration than in the former case. With the exception of one machine, all the competitors succeeded in climbing this hill on the low gear without a stoppage. The day's run—one of many similar runs which the machines are going through—was accomplished without a hitch, and the machines were all safely housed at Woolwich by six o'clock. It should be stated that the roads were in excellent condition—a remark which applies in general to the roads of Kent. The vehicles which made the day's trip successfully were as follows:—Class A: Commer car, with a four-cylinder engine 120 mm. bore by 140 mm. stroke; Dennis, with four-cylinder engine 110 mm. by 150 mm. stroke; Leyland, with engine 4⅝in. by 6in.; Maudslay, with engine, 5in. by 5in.; two Thornycroft's, one with an engine 4¼in. by 6in., and the other with an engine 4¼in. by 5in.; a Wolseley, with engine 4¼in. by 5in.; and a lighter machine to carry 30 cwt., built at the Royal Carriage Department, Woolwich, with a Leyland engine, 4in. by 5in.

The War Department specification for gear ratios is as follows:—First speed, 5 to 5.3 to 1; second speed, 2.9 to 1; third speed, 1.7 to 1; and fourth speed, direct. These ratios at an engine speed of 1000 revolutions per minute, give road speeds of 3.2, 5.5, 9.4, and 16 miles per hour respectively, and the competitors complied generally with these conditions. All the machines had live axles driven by double reduction spur gearing, with the exception of the Dennis, and one of the Thornycroft machines, which were driven by worm gearing. It may be mentioned that the loads of 4½ tons, carried by all but one vehicle, included water, petrol, lubricants, cab, body and officials, and this is the weight of machine which finds most favour with the builders.

During the runs so far there seems to have been no material difference in efficiency between the bevel and worm-driven vehicles, and it will be interesting to learn whether the tests will warrant the War-office in extending its specification so as to admit vehicles into the subsidy scheme with axles driven by well designed worm gearing.

## LONDON AND SOUTH-WESTERN RAILWAY—MIXED TRAFFIC LOCOMOTIVES.

TEN mixed traffic locomotives of the 4–6–0 type have recently been turned out from the Eastleigh Locomotive Works of the London and South-Western Railway. In a two-page Supplement we give this week a general drawing of these engines, and on page 535 is given a drawing of their tenders. We have already described these engines fairly fully, and from the drawings all the important dimensions and numerical data may be obtained. We need only say that two of the engines are designed to use saturated steam, while four of them are fitted with Robinson's superheater, and four with Schmidt's superheater. Both superheaters are shown in the drawings.

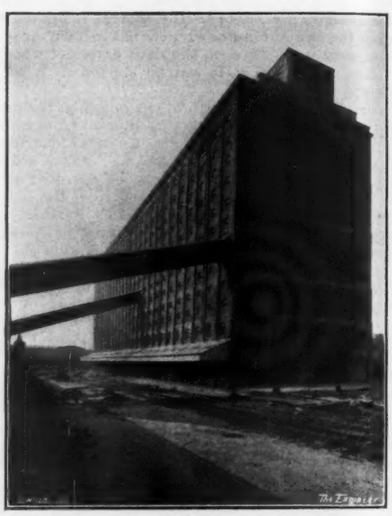
## A NEW GRANARY AT GLASGOW.

ON Thursday of last week the Clyde Navigation Trustees formally opened the new granary which they have had erected near Meadowside Quay, Partick. As a grain distributing centre Glasgow has for some time past been on the decline, and more than five years ago it was decided to keep pace with competing centres by erecting a new granary. Although the work has only now been brought to completion, the time which has elapsed has not been wasted, for it has made it possible to adopt all the most recent improvements which have been introduced into the design and construction of granaries and granary machinery during the past few years.

The new granary is 312ft. long and 72ft. in width inside and affords storage accommodation for 31,000 tons of grain. It is in two portions. One portion, 168ft. in length, is provided with silo bins and the other, 144ft. long, is arranged for floor storage. On the ground floor three lines of rails flanked by loading platforms run the full inside length of the building. Outside on the north and south sides verandahs are provided, under cover of which twenty-four carts or lorries can be loaded at one time.

In the silo bins the total storage capacity provided is 20,000 tons in 150 separate bins. Thirty-eight of these bins are 102ft. in depth and the remainder 84ft. The areas of the bins range from 12ft. square to 6ft. by 3ft., and their individual storage capacities from 275 to 20 tons. To guard against the grading of the grain when it is being drawn off from the bins, anti-grading cones are provided on some and Pottinger's patented distributors on others.

Eleven floors are provided in the floor storage portion of the building. Each floor when filled to a depth of 5ft. 6in. accommodates 1000 tons of bulk grain. The height of each section is 8ft. 6in., the top floor being 113ft. above ground level. Beneath the first floor is the sacking-off floor with a head room of 12ft. 6in. This floor extends from end to end of the building and is 15ft. 6in. above the ground, so as to permit railway wagons to pass beneath it on the rails alongside the loading platforms. Above the top floor is the conveyor gallery. This also extends from end to end of the building and is 131ft. above ground



NEW GRANARY AT GLASGOW

level. The main elevator tower is near the centre of the building and measures 36ft. by 24ft., with a total height of 160ft.

The structure of the granary is composite. Thus the outside walls of the floor storage portion are of brickwork and the interior structure is composed of cast iron columns, rolled steel joists and concrete floors. The outside walls of the silo portion are of reinforced concrete, but have a 9in. facing of brickwork so as to make the whole building uniform in external appearance. The division walls between the bins are of reinforced concrete. A staircase and passenger lift are provided for interior communication. The entire building and its subways are lit by electricity and all the machinery is electrically driven.

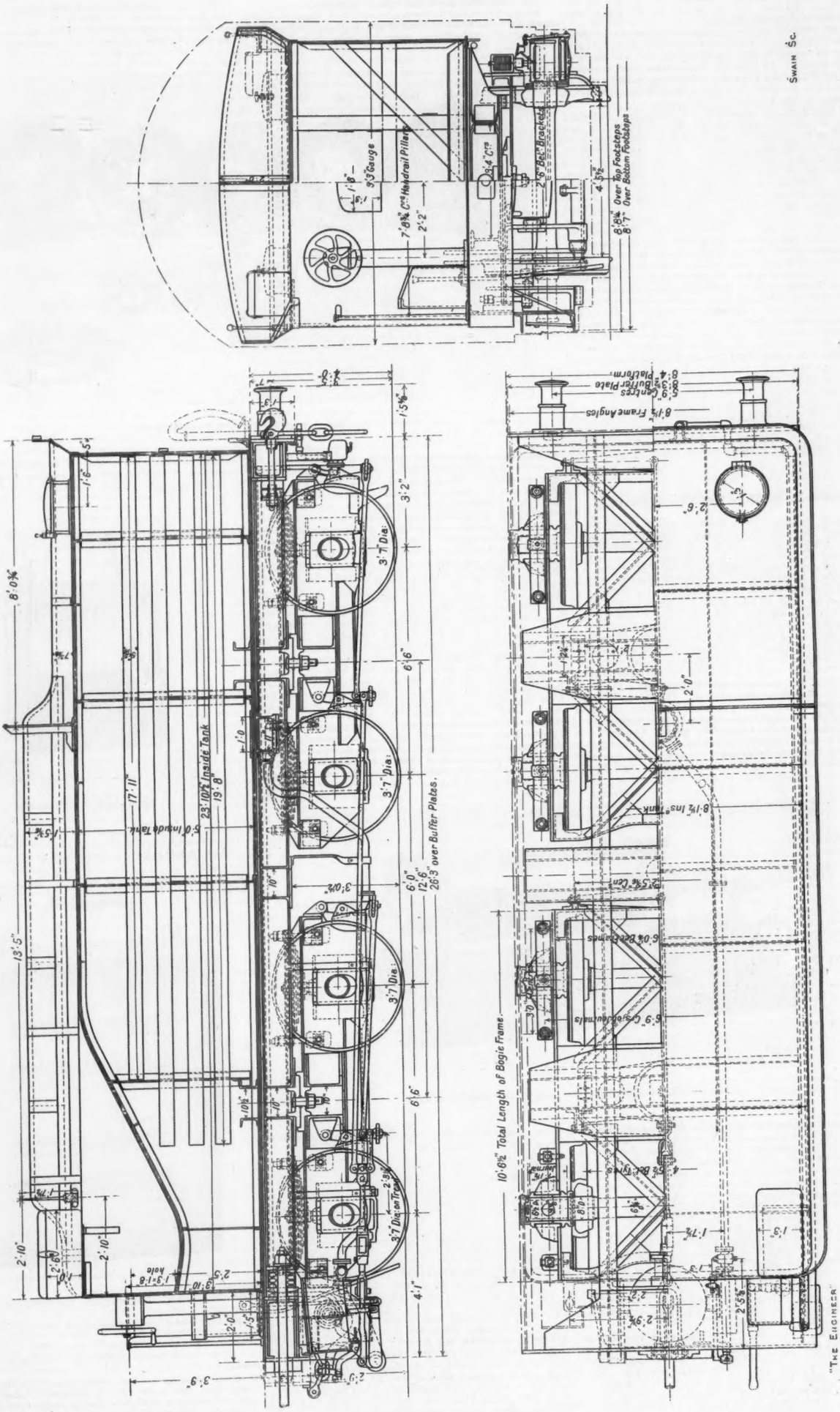
The arrangements made for handling the grain in bulk are very complete. On the quay, rails 900ft. in length are laid for two travelling ship-discharging elevators. Each elevator can handle 250 tons of grain per hour and is fitted with two 4000 lb. automatic weighing machines. After being weighed the grain is discharged on to band conveyors running parallel with the quay, and from these is delivered on to transverse band conveyors disposed in an underground subway connecting the quay and the granary. These conveyors take the grain to the foot of the two main elevators inside the granary. These elevators have each a capacity of 250 tons per hour and raise the grain to the conveyor gallery at the top of the building, where it is deposited on longitudinal band conveyors. Two of these conveyors work in conjunction with the silo bins, and by means of them the grain can be delivered into any one of the 150 bins. Two other conveyors are provided for distributing the grain to the floor storage portion of the building. These can deposit the grain on any one of the eleven floors by means of vertical down-spouts spaced 12ft. apart.

In the basement of the building several longitudinal and transverse band conveyors are provided, by means of which 100 tons of grain per hour can be turned over from one part of the granary to another. Such grain is taken to the main elevators and redistributed in the same way as grain entering the building from a ship. If, however, the main elevators are engaged on a ship's cargo the grain can be turned over by means of an auxiliary elevator running to the full height of the building. This elevator

# LONDON AND SOUTH-WESTERN RAILWAY—TENDER FOR MIXED TRAFFIC LOCOMOTIVE

MR. R. W. URIE, EASTLEIGH, ENGINEER

(For description see opposite page)



can be arranged to discharge the grain into an automatic weighing hopper, having a capacity of 3000 lb., on the ninth floor. In this way the weight of the grain being turned over can be determined.

On the sacking-off floor fourteen automatic weighing scales are provided. From this floor the grain, either in bulk or in sacks, is discharged by gravity into carts or railway wagons. In addition a transverse band conveyor is provided whereby the grain after being weighed can be delivered into the hold of a coasting steamer or lighter lying at a berth at the west end of the quay.

The arrangements made for the intake and handling of flour or grain in sacks comprise the installation of two inclined sack conveyors of the band type, each capable of dealing with 500 sacks per hour. These conveyors start from the floor of the goods shed on the quay and enter the granary at the level of the sixth floor in the floor storage portion. Between the shed and the granary these conveyors are carried on overhead steel gantries. Inside the shed they are carried by hinged gantries, whereby they can be lifted up towards the roof when not in use, so as to leave the shed free for ordinary traffic. The sacks on arrival on the sixth floor of the granary are distributed by a horizontal band conveyor and dropped by patented sack shoots to lower floors. One of the sack band conveyors is continued inside the building to the top floor, where it delivers on to a horizontal band conveyor and thus permits of the sacks being deposited on any of the floors above the sixth. The sacks coming in by way of the other inclined conveyor can be delivered on to the horizontal band conveyor on the sixth floor and thence carried to the top floor by way of a separate inclined conveyor. Thus both conveyors from the shed can command any one of the floors in the building. The loading out of the sacks into carts, railway wagons, or coasting steamers is effected by means of the same arrangements as described above for dealing similarly with grain in bulk.

The contractors for the building were Messrs. John Train and Taylor, of Rutherglen, Glasgow, and for the machinery Spencer and Co., Limited, of Melksham, Wilts. Some views of and in the building will be found on pages 534 and 538.

## A NEW PRECISION TACHOMETER SET.

IN order to supply the demand which exists for a tachometer set for giving precise measurements over extreme ranges of speed, the firm of Schäffer and Budenberg, Limited, Manchester, is introducing a set which will be found specially suitable for making tests of motor car engines and for work in physical laboratories, where ranges of speed from 100 to 4800 revolutions per minute are met with. The set comprises a small magneto-multi-generator or transmitter—shown in Figs. 1 and 2—and two measuring instruments or receivers—Figs. 3 and 4—of which Fig. 3 is a dial tachometer for the general determination of the speed of the machine, and the other—Fig. 4—a resonance type tachometer for exact measurements. The dial tachometer—Fig. 3—is essentially a volt meter of the electro-magnetic type, with the scale divided into revolutions per minute. This kind of device has been in use for some years for making electrical measurements. A solenoid excited by the current produced by the generator magnetises equally two soft iron segments, so that they repel each other with a force depending on the speed of the generator; one of the segments being fixed whilst the other is mounted, so that it can revolve freely in sapphire bearings, and, being fitted with a pointer, forms a sensitive and very reliable indicator. This part of the instrument is well damped, and weighs only 0·9 gramme. The resonance type tachometer—Fig. 4—consists essentially of an electro-magnet, the windings of which are excited by an alternating current, and a series of steel resonance reeds arranged in one or two rows within the field of the electro-magnet. These steel reeds are mounted on a frame, the free end of each reed being bent over at right angles for about ⅛in., to form the head which is coated with white enamel, so as to render it easily visible when vibrating behind the slot in the dial. In the angle formed by the head with the stem of the reed a small spot of solder is placed to give it the necessary weight. The reeds are made in various lengths to suit the scale required, and are carefully timed so that their speed of vibration synchronises with the alternations of the exciting circuit.

The advantages claimed for the resonance system are the absolute precision of indication which no ordinary usage can influence, its indifference to rough treatment and lapse of time. Further than these, the degree of accuracy of the indications is not liable to be affected either by variation in the resistance of the conducting cables or by the voltage of the magneto generator. The indication, in short, depends solely on the frequency of the impulses or the number of revolutions of the generator.

Simple resonance systems actuated by a single generator with only one fixed number of alternations per revolution are suitable only for a range of scale extending as a maximum to twice or four times the initial speed, as, for instance, 100–400, 200–800, or 400–800 revolutions per minute. With the employment of a multi-generator—Figs. 1 and 2—capable of producing for each revolution a number of different alternating values, it is easy to multiply the range of measurement by successively switching on the generator systems with a lesser number of alternations as the speed increases. The multi-generator illustrated in Figs. 1 and 2 consists, as will be seen, of four small alternating-current generators, with 24, 8, 4 and 2 alternations per revolution respectively for actuating the resonance tachometer, and also of a small magneto inductor for actuating the dial and finger indicator. $C_1$, $D_1$, $E_1$ and $F_1$ are the armature windings of the alternating-current generators, and $G_1$ the armature winding of the magneto inductor. C, D, E and F are the casings containing 24, 8, 2 and 4-pole electro-magnets respectively, and G is the casing containing the permanent magnets of the magneto inductor. It will be observed that all the armatures are mounted on a common shaft revolving in ball bearings and driven by means of a flexible shaft or strap from the engine or other shaft, whose speed is to be indicated. The rotating masses are remarkably small, and the whole forms a common rotor of very slight momentum. During the test the magneto inductor continuously actuates the dial indicator, while of the four alternating-current generators only one at a time is excited by turning the pointer of the lever switch shown at the left-hand corner of the base to the disc which shows the speed range shown by the small indicator.

To use the testing set, the magneto inductor is first connected to the small dial indicator, which is merely intended for averaging the speed and to act as a guide for switching on one of the four alternating-current generators. To effect this expeditiously, a thick line is provided underneath the scale of the dial indicator, divided into four sections, each of a different colour, the colours corresponding with those of the figures of the four scales of the large resonance tachometer—Fig. 4—as follows:—Blue for speeds 100–400; number of poles of induction, 24. Red for speeds 300–1200; number of poles of induction, 8. Black for speeds 600–2400; number of poles of induction, 4. Green for speeds 1200–4800; number of poles of induction, 2.

If, now, the pointer stands over the blue segment of the dial, the 24-pole generator is excited with continuous current by switching the lever of the switch to the blue circle—marked also 100–400—and the blue figures are read on the four scales of the large resonance indicator. If the speed increases beyond 400, *i.e.*, if the finger stands over the red mark, the switch is moved over to the red circle—300–1200—thus exciting the 8-pole generator. The red figures on the four scales of the large indicator are then read. There are 4 × 61 × 244 reeds, each of which can be excited in four different ways by means of the four generators, so that there are obtainable 4 × 244 = 976 exactly calibrated values. As, however, all intermediate values between two reeds can be determined exactly a very high degree of accuracy or precision is obtained. To excite the four alternating-current generators a small portable 12-volt accumulator may be used, or current from a high-pressure main of 100 or 200 volts. The consumption of current at 12 volts is about 1 ampère for the 24-pole generator, and a little less for the generators with lesser number of poles which are used for the higher speeds.

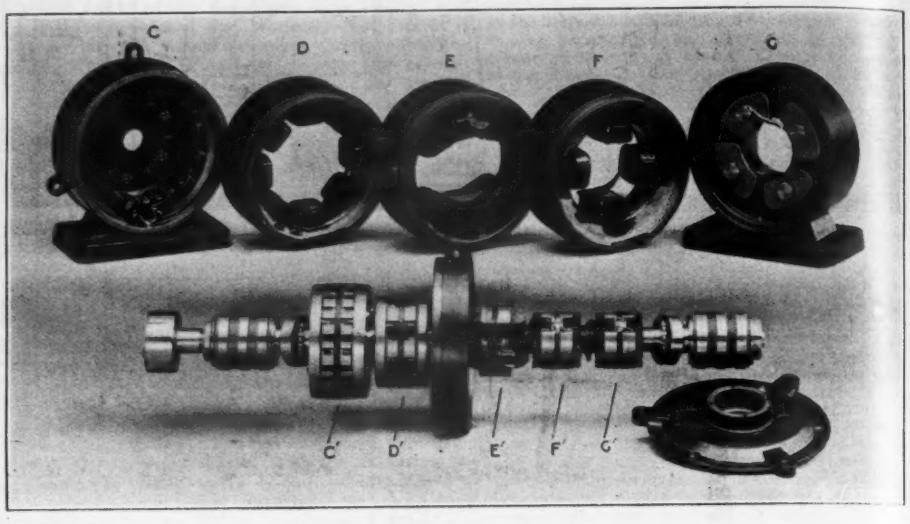



Fig. 2—DETAILS OF MULTI-GENERATOR

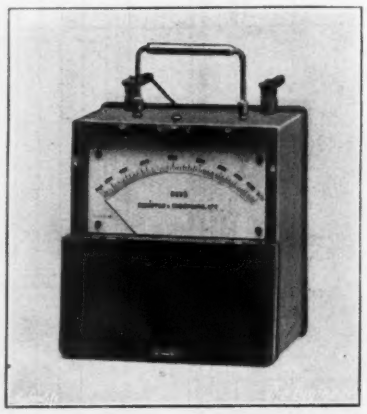


Fig. 3—DIAL TACHOMETER

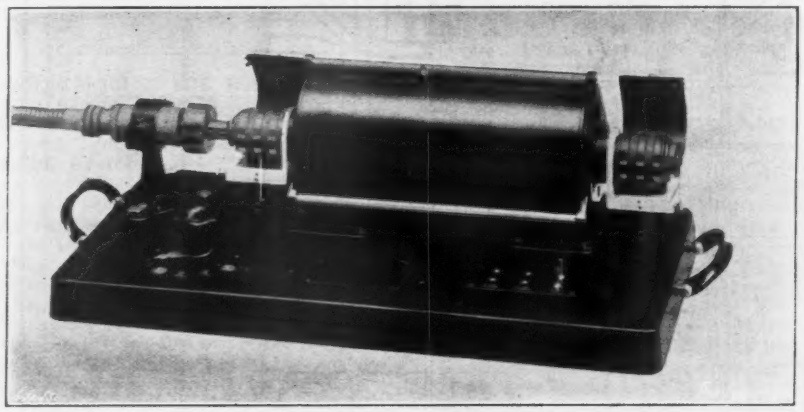


Fig. 1—MULTI-GENERATOR FOR PRECISION TACHOMETER

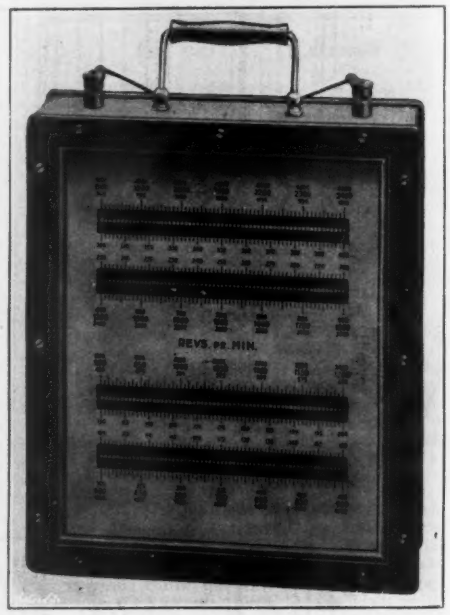



Fig. 4—RESONANCE TACHOMETER

THE ASSOCIATION OF CONSULTING ENGINEERS (INCORPORATED).—The annual general meeting of the association will be held at Caxton Hall, Westminster, on Monday, May 25th, at 4 30 p.m., when the report of the committee and the accounts for the past year will be presented.

## RAILWAY MATTERS.

THE Sudan Government Railway engineers have now completed the survey of the projected line of railway from Suakim to Tokar, the centre of the great cotton growing district of that name. The line, as surveyed, will be some 50 miles in length, and the cost of construction will be met from the loan of £3,000,000, the interest upon which has been guaranteed by Great Britain.

THE Prussian State Railways have ordered experimental rolling stock for the City and Ring Railway from the Maffei-Schwartzkopffwerke, Siemens-Schuckert, A.E.G., Bergmann and Brown-Boveri firms, and have commenced trials of one complete train on their Dessau-Bitterfeld line. This train of twelve coaches can be split into two sections, and is stated to have only two four-wheel motor bogies. Separate compartments, with a narrow side corridor, are likely to be adhered to.

THE Swiss Railway Department has drawn up a scheme for the adoption of electric traction on the St. Gothard Railway between Erstfeld and Bellinzona, which is estimated to cost 37 million francs. Single-phase current will be used at 15,000 volts; but owing to the necessity of using steam traction and electric traction simultaneously during the conversion, a pressure of 7500 volts will be provisionally adopted. It is stated that the scheme will enable the importation of coal to be reduced by two to three million tons a year. Battery locomotives, charged at night, will be used in the yards and for local traffic. There is plenty of water power in the neighbourhood of the line.

AT a conference held in Paris on Monday, May 11th, between representatives of the Brighton Railway Company and officials of the State Railways of France, many improvements and accelerations in the services between London and Paris, *vid* Newhaven and Dieppe, were arranged to come into operation next year. The morning services from London and Paris will be accelerated by about half an hour in each direction, and an afternoon service between London and Paris will be run during the summer months. The State Railways have ordered for these services another fast turbine steamer, to be named the ss. Versailles, from the Forges et Chantiers de la Méditerrannée.

THE Sheriff's jury which inquired into the deaths of the driver and fireman of the express concerned in the Burntisland accident of April 14th, returned, on the 7th inst., a verdict that the mishap was caused by an error of judgment on the part of the signalman at the Junction box lowering his signals for the express before it had been "accepted" by the East signalman. The jury further found that the accident would have been avoided had the driver of the express responded to the distant signal for the East box, which was against him. The jury recommended that there should be mechanical control over the signals, and the company's inspector said that there was no reason why this should not be adopted.

COLONEL E. DRUITT'S Board of Trade report on an accident which occurred on the Rochdale tramways on February 14th, when a car attained a high speed descending an incline, and subsequently left the rails on a curve, colliding with a tramway standard and dashing into a shop window, has now been issued. The inspector attributes the accident to the driver allowing too high a speed to be attained before applying his magnetic brake sufficiently, and when putting it on the last notch suddenly skidded the wheels. It was impossible to find whether there was any defect in the brake control, owing to damage done by the collision, but it is stated that the driver had not previously tested the brake. The design of the sand boxes is criticised.

REPORTING in *Elektrotechnik u. Maschinenbau* on the progress of electric traction in the United States, Dr. Neithammer writes that the General Electric Company recently supplied one of the 80-ton direct-current locomotives for the Butte Anaconda Railway with direct-current at 2400 volts from a 1000-kilowatt mercury vapour rectifier. The rectifier was supplied with three-phase current at 60 cycles. An almost uniform direct current was obtained. The current from a single-phase rectifier is of a pulsating nature and would necessitate special motor construction. If mercury vapour rectifiers are ever used for traction work they will probably be large units in substations supplied with three-phase current of any periodicity, as if placed on the locomotive a double overhead conductor would be required for the three-phase supply.

AN automatic ticket-issuing machine has recently been installed at Victoria Station by the Metropolitan District Railway Company, which, according to *Electrical Engineering*, performs the operations of printing, numbering, dating and cutting off of the tickets. The machine, which is set in action by depressing levers, will print any of five different kinds of tickets, and is big enough to deal with ten kinds if required. The driving power is obtained through a chain drive, from a 6 horse-power direct-current series-wound 200-volt motor, which in turn is fed from the direct-current mains, which have a voltage of about 550, through resistances. The motor is of ample power, so that when the starting lever is depressed, full speed is rapidly attained. Automatic counters are fitted, so that the exact number of any particular kind of ticket which has been sold can be readily seen.

OWING to the rapid increase of business on the Oakland, Antioch and Eastern Railway, it has been necessary to place in operation two 62-ton continuous-current locomotives to deal with the heavy through passenger traffic between San Francisco and Sacramento. According to the *Electrician*, each of these locomotives is capable of hauling five passenger cars, weighing 37.5 tons each on the level at 56 miles per hour. The locomotives are composed of two articulated trucks, each having six wheels, four of which are drivers, making a total of eight drivers per locomotive. Each group of wheels consists of two pairs of driving wheels and one two-wheeled radial truck has an independent frame. The cab is mounted on a separate frame, which is supported on the truck frames by eight spring-loaded friction plates, no draw-bar pull being transmitted through the cab. The cab centre pins carry no weight, and are used simply to maintain the position of the cab with respect to the trucks.

## NOTES AND MEMORANDA.

THE largest single use for silver, outside of the manufacture of silver-plated ware, is, according to the *Brass World*, in the manufacture of photographic plates, films, and paper. The manufacture of films for moving picture use has now become an enormous business, and it is probable that in the future this will bring the largest consumption of silver. The silver is used in photography for making the light-sensitive emulsion and is principally the bromide of silver.

A NOVEL method of preventing local fogs is at present being tested by experiment. During the winter months Lyons is frequently covered with dense fogs, caused by evaporation from the neighbouring rivers. The Director of the Lyons Observatory has shown, from the contour of the land and the movement of fog banks, that if evaporation from the Saône could be checked for a stretch of about a mile and a-half above Lyons, fogs over the town would be prevented. To effect this, 72 litres of oil are being spread over the surface each day. This small amount gives an oil film thick enough to stop the evaporation.

IT is reported that a German engineer named Knobel, living at Munster, has invented a more or less invisible aeroplane, which is considered in military circles to be of considerable value for war purposes. Instead of having the ordinary cloth fabric, or other visible material, used for the wings, this particular aeroplane is constructed of a transparent variety of celluloid, which is likewise stated to be fireproof. The wings, thus made, let the light through, so that at a height of 3000ft. it is almost impossible to detect the aeroplane at all. The machine is also fitted with a silent motor. A further advantage is that the aviator has an unobstructed view in all directions.

THE Pittsburgh Crucible Steel Company has recently installed a 600-ton hot metal mixer. Some interesting tests showing the power required to operate this mixer have been made recently. The figures indicate that 137 horse-power is necessary to start the mixer downward and 230 horse-power to start it upward. After it is in motion a maximum of 79.4 horse-power is absorbed in tilting downward and 72.4 horse-power in tilting upward. These readings were taken with the mixer empty. The mixer is 40ft. long, 13ft. wide, and 29ft. high. The shell is constructed of 1in. steel plates, supported by a 15in. I-beam frame. The lining is of fire-brick 18in. thick, and there are two inspection doors on each side.

WRITING in the columns of *Power*, a correspondent says:—In a producer gas power plant, which came within his observation, considerable trouble was experienced with the engines missing. An investigation showed the cause to be in the make-and-break ignition system, the heat from the spark periodically welding the nickel composition electrodes together; they would stick for a time, causing the engines to miss, then break loose again. These nickel composition electrodes were replaced with cast iron electrodes, and there was no further trouble from this source. The arcing surfaces of the cast iron electrodes seemed to wear smoothly, not having the tendency to pit and corrode, as in the case of the other electrodes.

THE making of a blue print from a blue print is described by a correspondent of the *Concrete Record* as follows:—To obtain good results, a clear, sharp, and rather dark print is essential, for if it is blurred or light it will not reproduce satisfactorily. The method consists of coating the print with a little kerosene and then printing immediately. The oil used will not affect the reproduction of the new print, unless it is applied very thickly, nor will it spoil the original, as the oil soon dries, leaving the print in as good condition as before. This process, it is stated, will also work perfectly when it is desired to make prints from heavy drawings. It has been used with success to make blue prints from printed matter. To make the original perfectly transparent, a coat of boiling hot paraffin is applied.

A STEAM machine has been recently subjected to a long test on a concrete road in Ohio, in connection with the process with which liquid asphalt and other ingredients are mixed cold, with sand and stone, and spread on the road. The machine has a capacity of 20 cubic feet of material that has not been mixed, or of 15 cubic feet of mixed concrete. The loading skip is 8ft. wide, permitting three wheelbarrows to be emptied at once. The engine is placed in the centre and the boiler is underslung. The loading skip has a very wide nose, so that it discharges into the mixer quickly and without any tendency to clog. The distributing spout is 15ft. long and is equipped with blades. As it revolves it continues mixing the batch up to the point where it is discharged into the street. The machine will handle three batches at the same time. While one batch is being loaded into the skip another is being mixed in the drum, and the third is being discharged from the distributor. All the levers are grouped in one place, so that the engineer has complete control of the machine, which is equipped with steering wheel, forward and reverse traction mechanism, and compensating gears similar to those used in a motor car.

MANY steam users are under the impression that when boilers or vessels to which steam is admitted for heating and boiling purposes are worked at low pressure failure cannot produce serious results, though experience often shows this assumption to be untrue. In the early days of steam many terrible boiler explosions occurred, although boilers were then of a primitive type, and pressures used only a few pounds on the inch, which is insignificant as compared with modern practice. In the event, however, of the sudden rupture of a large boiler, even when working at low pressure, the amount of energy liberated is capable of doing great damage. In the May issue of the *Vulcan* is an illustration taken from the *Illustrated London News* for December 27th, 1845, showing the havoc wrought by the bursting of a wagon boiler at a cotton mill at Bolton. The boiler was of a type which was incapable of resisting a high pressure, and though the actual working load is not stated in the brief account of the disaster, it seldom exceeded 12 lb. to 15 lb. on the inch. All the same, it sufficed, as the illustration shows, suddenly to convert a large part of a four-storied mill into a heap of ruins and kill ten workpeople, while nine others were more or less seriously injured.

## MISCELLANEA.

AS we go to press, we are in receipt of a Marconigram from our correspondent on board, informing us that the German liner Vaterland left Cuxhaven pier at 12.45, English time, yesterday on her maiden trip, and was expected to arrive at Southampton about 11 o'clock on this—Friday—morning. It was anticipated that she would make 23 knots.

THE Board of Trade has issued a report on the explosion from a boiler stop valve chest at Pinkston Tramway Power Station, Glasgow, on November 10th, 1913. The explosion, by which no person was injured, was found to have been due to the long-continued action of superheated steam on the cast iron, causing disintegration and deterioration of the material of the valve chest, and it is added that a number of manufacturers have entirely ceased to use cast iron, when superheat is specified, not only in land installations, but also in connection with marine work, as they do not consider it reliable.

ALTHOUGH the list of entries for the aerial "Derby" on Saturday, May 23rd, does not officially close till next Monday, fourteen entries have, according to the *Manchester Guardian*, already been received. Eleven of them are from English, two from French competitors, and one is to be announced later. It is anticipated that at least twenty machines will take part in the contest. Extra accommodation has been provided in the enclosures at the Hendon Aerodrome, where the start and finish of the race may be seen. If the day is clear the leading pilot will first be discerned when he is about five miles away.

IT is announced from the United States that a number of case-hardening and heat treating foremen employed at the numerous motor car factories in Detroit and district have organised a society to be known as the Steel Treating Research Club. Meetings will be held once a month, when metallurgists and men who can impart scientific knowledge on the subjects of case-carburising, the heat treatment of carbon and alloy steels, and various grades of tool steels, will give lectures on those subjects. The club being intended solely for educational purposes, membership will be restricted to foremen of case-hardening and heat treating departments, tool smiths, and tool hardeners.

SERIOUS subsidences in the Tees salt district at Haverton Hill were referred to in a report presented to the Stockton-on-Tees Rural Council. It was stated the "fall" in some of the houses had been as much as 9ft. 6in. All the streets near the salt wells had subsided, and the whole of the sewers and drains had had to be relaid. The destruction in three streets, particularly had been very great, the walls, doors, windows, floors, paved yards, drains, &c., having been cracked and broken. In some cases the damage had been beyond repair and the houses had been closed. Considerable damage had also been done to new schools at Haverton erected by the Durham County Education Committee.

IN the House of Commons recently Mr. H. Nield asked the First Lord of the Admiralty whether he or the Board of Admiralty had received offers to demonstrate the value of submitted inventions which had for their object the prevention of loss of life through submarine disasters; whether such offers had been declined; and, if so, whether the policy of refusing these offers had his sanction. Mr. Churchill, replying, intimated that a large number of plans for preserving the safety of crews in submarines had been submitted from time to time. All inventions received were carefully examined, but no plan submitted up to the present had been adjudged worthy of a trial or adoption in the British Navy.

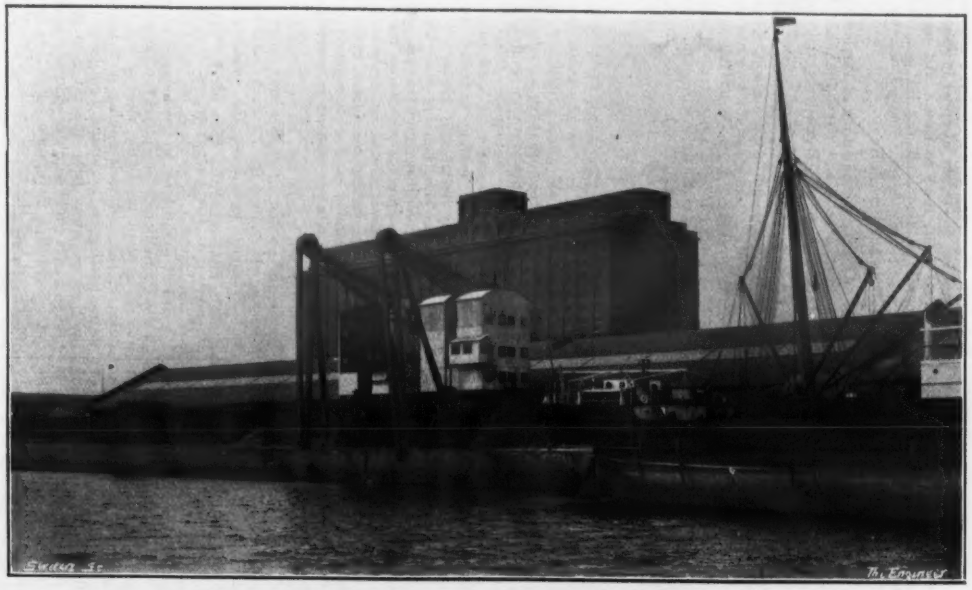
THE first congress and tour in England of the International Garden Cities and Town Planning Association will be held in July next. Housing by municipal authorities, by public utility societies, and by private individuals and companies will be inspected, the various towns to be visited being London, Birmingham, Chester, Liverpool, and Letchworth. An extension tour has also been planned to Scotland, visiting Edinburgh, Glasgow, and a number of the beauty spots of the country. The congress will be attended by parties from America, Austria, Canada, France, Germany, Italy, Poland, Russia, and Spain. The actual sessions will be short, the papers being circulated beforehand, so that time may be devoted to discussion.

IN reply to Mr. George Lloyd, who asked the Home Secretary whether, in view of the Senghenydd and other disasters in the coal mining industry, he proposed to take any legislative steps with a view to increasing the safety of those employed in mining, Mr. McKenna said:—"I do not anticipate that the Government will be able this session to introduce any legislation in regard to the mining industry beyond the Bill which is already before the House. I may point out, however, to the hon. member that the question of the prevention of coal dust explosions and other points which have been raised by the reports on the Senghenydd and other recent disasters can be dealt with by regulations under the Act, without legislation, and I hope, as soon as the inquiries now in hand are completed, to propose regulations dealing with the matters in question."

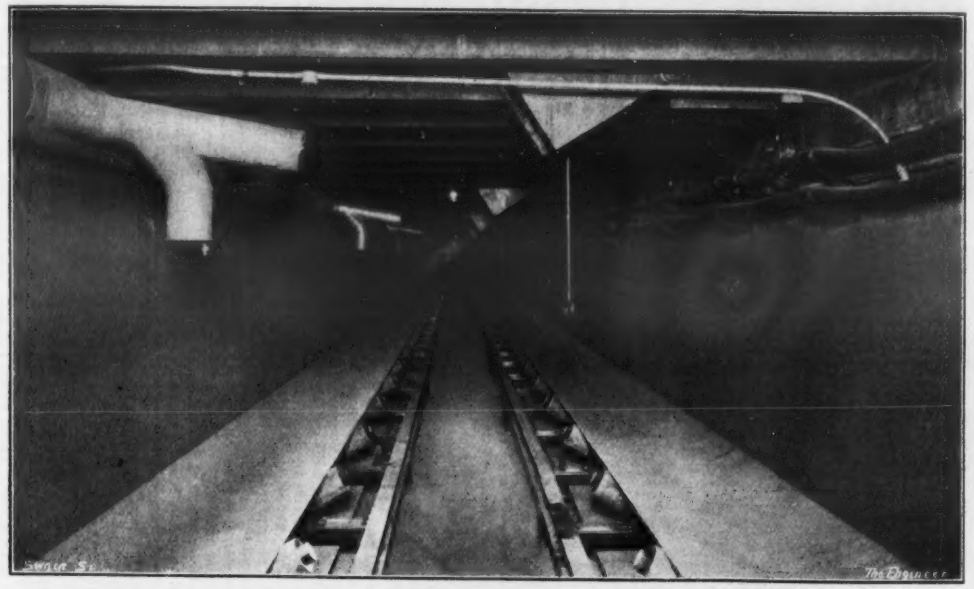
LECTURING before the Royal Geographical Society at Burlington-gardens last Monday night, Dr. Vaughan Cornish, who visited the Panama Canal Works in January and February last, gave the conclusions, with regard to the safety of the work, at which he had arrived. He said that the only part of the Canal which was not finished was a portion of the Culebra Cut, about a mile and a-half long, in the neighbourhood of Gold Hill. It was officially estimated that the loose ground which was now in motion would be cleared out by August. The slides in the bad rock having now broken back to the water parting, a beginning had been made in sluicing the material away from the cut, and by this means the broken banks could be reduced to any extent desired without interrupting navigation. For this reason Dr. Cornish considered that the Canal would ultimately become a safe and satisfactory waterway. The slight earthquakes which had occurred frequently during the last few years had done no damage to the Canal works.

# MEADOWSIDE GRANARY, GLASGOW

(*For description see page* 534)



GENERAL VIEW OF GRANARY AND QUAY FROM RIVER



BAND CONVEYORS IN SUBWAY IN QUAY WALL

CONVEYOR GALLERY SHOWING THROW-OFF CARRIAGE

SACKING-OFF FLOOR, SHOWING HOPPER-BOTTOMS OF BINS

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*** *With this week's number is issued, as a Supplement, a Two-page Drawing of a Mixed Traffic Locomotive, London and South-Western Railway. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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☞ *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

# THE ENGINEER.

*MAY* 15, 1914.

### The Burning of the Scout.

We have deliberately refrained from dealing with the burning of the motor ship Scout, which took place on August 19th last, until we could have before us better evidence than could be obtained at the time as to exactly what did take place. This we now have in the form of the Board of Trade report on the subject, which has just been issued. The finding of the Court of Enquiry is as follows:—"The Court having carefully inquired into the circumstances attending the above-mentioned shipping casualty, finds for the reasons stated in the annex hereto, that the loss of the motor vessel Scout was due to fire which originated in the engine-room of the vessel. The fire was caused by the ignition of oil in the bilges. The said ignition was probably caused by some oil from the bilges being thrown by the revolving fly-wheel of the port engine on to a hot exhaust pipe."

The formal inquiry was opened on January 21st, but was adjourned to March 19th in order to enable tests to be made as to whether bilge water could be thrown up by the fly-wheel on to the exhaust pipe with the two parts in the actual relative positions which they occupied in the ship and to determine whether oily bilge water when so thrown up would ignite. In this connection the following extract from the report should be borne in mind:—"The exhaust pipe for the port engine was situated about 16in. above the fly-wheel and about 20in. to port of same—centre to centre. This exhaust pipe was covered with asbestos rope lagging for a short distance, but some parts of the pipe were slightly exposed at the bend, and the chief engineer stated that at various times he had noticed the pipe at a dull red heat in the openings between the coils of asbestos. He admitted that he had never complained to anyone about it, as he did not attach much importance to it." The experiments were carried out at the works of Burmeister and Wain, in Glasgow, a fly-wheel of 30in. diameter being run at 450 revolutions per minute over a trough 4ft. by 1ft. to represent the bilges. The first experiment proved what is well known to all who have had experience of motors in small boats, namely, that bilge water, if it be allowed to rise above the rim of the fly-wheel, will be thrown about and will reach anything in line with it within 2ft. or 3ft. all round the rim, though the volume is naturally reduced on the side on which the rim is re entering the water. However, it was no doubt desirable to prove beyond question that bilge water could reach the exhaust pipe as fitted in the ship. The next experiment showed that a mixture of pure lubricating oil and water thrown up by the fly-wheel would not ignite upon the pipe, even when the latter was heated to a bright red; the oil simply passed off in a thick cloud of smoke, though this smoke ignited in the presence of a naked flame. It is perhaps to be regretted that this test was carried out with pure—which we take to mean fresh, unused—lubricating oil, as it is quite possible for a lubricating oil which has a high flashpoint when new, to have its flashpoint considerably lowered, owing to fuel oil admixture after it has been in use in a motor for some little time. One of the oil experts called as a witness at the inquiry admitted that a lubricating oil with a flashpoint of 400 deg. Fah. open test, might have its flashpoint reduced to as low as 85 deg. by the admixture of paraffin, though he gave no figures as to the proportions of the two oils. The point is not of great importance, as in a later experiment a mixture was used, but an experiment with old oil would have been more satisfying. But a more serious error presents itself in the next experiment, and we are not satisfied that the conditions actually existing on the ship at the time of the accident were accurately reproduced by it. In it finely shredded cotton waste was thrown on to the hot pipe in order to represent the asbestos lagging with which the pipe on the ship was covered. This cotton waste was naturally immediately burned up, but it left glowing particles on the pipe, which approached the condition of a naked light. There is no evidence that similar glowing particles were present on the Scout, and the report says nothing about the lagging having been frayed, which might have led to glowing fibres, but only that the pipe could be seen through "the openings in the coils of asbestos" at the bends. But even under these favourable conditions the pure lubricating oil did not ignite very readily—with asbestos coils we venture to doubt that it would have ignited at all. The report does not state whether the final experiment was again carried out with these glowing particles of charred cotton waste or not, but perhaps the point is immaterial. A gallon of paraffin was added to the mixture in the trough, giving approximately equal proportions of lubricating and fuel oil, and probably reducing the flashpoint of the mixture to the neighbourhood of 85 deg. to 100 deg., and this at once burst into flames on reaching the exhaust pipe. It may, therefore, be taken that even though we wipe out the second experiment altogether and admit that the proportion of paraffin to lubricating oil in the third experiment was higher than is likely to have been the case at the time of the accident, there is quite enough evidence to show that such an accident could happen if the exhaust pipe were allowed to reach a bright red heat. At all events, the Court was satisfied upon the point, and the report goes on to state the opinion of its members:—"We are of opinion that the exhaust pipes of *all* motor vessels should be efficiently cooled; that the fly-wheels should be properly cased in; that the bilges should be sounded at regular intervals and recorded on a board kept in the engine-room; that the contents of the bilges should be pumped out at regular intervals and recorded in the engineer's log book, where a log is kept; that proper provision should be made for pumping out all compartments in the machinery spaces; and that the owners of motor vessels should see that the chief engineer is provided with the Board of Trade's instructions and regulations relating to motor machinery."

This series of recommendations, as we presume they must be taken to be, would seem to infer that the accident was due to the want of proper regulations with regard to the installation of motors on board ship. We, however, venture to think that it was not due at all to the need for further regulations, but to the failure on the part of someone to carry out the regulations of the Board of Trade as they already exist, that is, if what are called "instructions" have the force of "regulations;" for the neglect to pump out the bilges was only a contributory cause. The "Instructions for the Survey of Passenger Steamers," issued by the Board of Trade, clearly state that "The tank . . . should rest in a . . . suitable lead-lined or metal tray situated above the deep load-line, with drain pipes from the tray leading overboard," and, further on, that "the exhaust pipe should be efficiently cooled to prevent danger." Though these regulations were issued, we believe, in 1909, while the Scout was built in 1907, it is clearly stated that they shall apply "to all motor boats which come under survey for the first time." The Scout was surveyed, according to the report, in July, 1913, when, if not before, the necessary alterations should have been made to bring her into accordance with the regulations. If the first instruction quoted above had been observed, it would have prevented fuel oil from leaking into the bilges, while the second—lagging with asbestos cord cannot be described as "cocling"—would have prevented the ignition of oil even of a low flashpoint.

The report contains one or two other points which seem to us to demand some comment, the most extraordinary of which is contained in the following quotation:—"Water drip was used in the cylinders, as is usual in this type of engine, for deadening the explosions, and the amount of water drained from the cylinders into the bilges before the engines were started, after standing for some considerable time, would be about one gallon." We must admit that we find it very difficult to understand what this means. If the water drips were left running after the engine was stopped, or if the drips were in a leaky conditions, water could accumulate round the inlet valves, and if these valves were tight, water would stand there and be drawn into the cylinders when the engines were turned; if the inlet valves were leaky, the water would enter the cylinder and accumulate there, though how it could be "drained from the cylinder into the bilges before the engines were started" and to the extent of "about a gallon," we admit we cannot understand. The only other way in which water could accumulate in the cylinders would be from a leak in the water jacket, which should have received attention. The report gives no indication as to the

source from which the information was derived upon which the above statement was made, but it appears on the face of it to be so serious an indictment of the water-drip system that we suggest to the builders of the engines that they should investigate the matter further. Further on, the report states :—" Any leakage from the filling or the sounding pipes, or from the sides of the tank, would be noticed at once, but a leakage from the bottom might escape into the bilges without being observed. It is desirable therefore that fuel oil tanks should be elevated as high as possible so that the bottoms can be kept under observation." On this, we need only remark that the tray draining overboard as demanded by the regulations would alone have provided the necessary safeguard.

Surveying the report as a whole, we are forced to admit that it is unsatisfactory in itself and reveals an unsatisfactory state of affairs. Regulations designed to ensure the safety of motor vessels have been laid down, and it is in the highest degree desirable for the good of the industry, and the safety of passengers and crew, that those regulations should be rigidly observed. In the case of the Scout, the report leads us to believe that they were neglected in important particulars. Why they were not insisted upon when the Scout was surveyed in July, 1913, is a matter on which we should be glad to have the Board's explanation. It is possibly lacking from the report because the Board would have found itself in the position of commenting on its own neglect of its own " instructions."

### Failures of Steel Plates.

THE problems of steel seem, in some respects, near akin to those of heredity. We say that a child is like his mother, or shows the same characteristics as his father, but no man dare say that a child *will* resemble one or display the same characteristics as the other ; often enough he follows neither one nor the other in any respect. It is thus with steel. We say that under certain conditions steel plate fails, yet if we repeat the conditions as nearly as we can within the limits human skill permits, we may produce a plate that fulfils all the tests we impose and is perfectly sound. Out of a hundred thousand plates one fails, and on examination we discover defects that we call the cause, but we have no notion how many of the remaining nine hundred and ninety-nine have exactly the same bad qualities and yet live through their term of useful work with honour to themselves and credit to their makers. In both cases, heredity and steel, science forces us to come to a single conclusion—that our knowledge is still defective ; that we are still unable to estimate the effect of apparently insignificant factors which by reacting upon each other throw our estimates out of balance and leave us still floundering in uncertainty. The modern well-trained mind rejects altogether from its vocabulary the word mystery. Mystery is to it something unexplained, not something unexplainable, and it says, quite properly, that there is a cause which may be defined and against which we may take the proper safeguards, once we know it, in every failure of steel. This is the right attitude, for it is the only attitude that makes continued research and inquiry worth while, the only attitude which leaves us with the certainty that there is an outlet from the problems that face us, and that we are not trapped in a maze which leads us round and round in circles but ever returns us to the point from which we started.

The paper which Mr. Sidney Houghton read before the Iron and Steel Institute on Friday last is one of those contributions to knowledge which throws light upon dark places. Mr. Houghton has taken a large number of mysterious failures of steel plates and has examined them in detail. He has considered the analyses of the plates and their micrographical structure, and has studied their physical tests. From the examination after failure, the *post mortem* examination, he has endeavoured to determine the faults of manufacture, of composition, and of treatment that has led to their demise, and, although many may disagree with the relative importance of these three factors to which, as no one before, he has attempted to give a quantitative value, yet all will agree that he presents a case which gives much food for thought. If we have a regret it is that he, as far as his paper tells us, made no control examinations. He did not take plates which had not failed and endeavour to find out if they were intrinsically different from those which did fail. His attack is largely directed against hammer dressing of surface defects. Out of twenty-one failures, in more than half hammer-dressing appears as a contributory cause of failure, and sometimes a very high percentage value is allowed to it as compared with other contributory causes. But hammer-dressing is—or rather was, for grinding is taking its place—a very common shop operation, and many thousands of plates so treated must have proved wholly satisfactory. Indeed, few boiler plates escape severe treatment in the course of manufacture, and yet failure is the exception rather than the rule. The works fly in the face of the teaching of the school, and disaster does not wait on them, or waits so rarely that they are indisposed to ascribe it to the causes the professors and laboratory workers allege. Let any student watch the operation of putting the end plates into a big Scotch boiler. Its face is pounded just at the bend of the flange with dollies and sledge hammers to drive it into the barrel and to adjust it in position for riveting. Such localised punishment must set up local stresses, which ought to render the integrity of the plate uncertain in the extreme, and yet hundreds of boilers are so made year after year, and seem none the worse for it. Alarmists assert that smoking causes cancer of the tongue—on the evidence that the disease is more common in men than in women—but few indeed are they that refrain from smoking on that account. The steel maker and the steel user put themselves in the same position. They say we are told that this thing and that is the cause of failure, but we have done these very things time out of mind and we have rarely, or never, had a mishap. The fact is that no scientific law can be regarded as established until we can repeat the phenomenon it governs at will. If you pour hydrochloric acid on marble you know with absolute certainty that carbonic acid gas will be given off ; if you put iron in water you know it will rust ; if you put steam in a condenser you know it will return to water. The steel maker knows that too much phosphorus will make his steel cold-short and too much sulphur will make it red-short. All these things are definite and certain ; as often as we repeat them we get the same result. But of steel failures we cannot speak with the same confidence. Deliberate attempts to make steel bad by doing the very things the steel maker is told not to do have often left the sample as good as before, whilst on the other hand plates made with all the care in the world have ultimately proved useless.

We do not say all this with any idea of depreciating the work of the scientific worker, but rather to excuse the maker and the user if they are found hard of belief. We look to the time when there shall be no failures at all of steel plates, or steel rails, or steel axles. That time will not be reached until we have accumulated so much knowledge that the effect of everything we do to, or put into, steel is known. Mr. Colville and Mr. Richards hinted at the meeting that they knew all about the causes of failure, and that they intended to keep the facts to themselves. We trust that is a position from which they will see the propriety of moving. There are certain branches of knowledge which cannot be regarded as proper commercial assets. Many lives have been lost by the failure of steel in one form or another, and we agree with Mr. Stead that " if steel makers do really know all about it, then they ought to sacrifice something on the commercial side in order that the public may be saved the risk of disaster." We do not think that steel makers can prevent the investigator from finding the truth, but they may delay the discovery, and we suggest to them that it would be both more gracious and more politic to help rather than to hinder his researches.

### Light Railways.

THE promotion of light railways continues to be characterised by no undue haste on the part of those who are interested in this method of transport, and the existing position of affairs forms a striking contrast to the practice which was followed towards the end of the past and the beginning of the present century. At that period the private promoters of electric tramways perceived in the Light Railways Act a means whereby they might attain their objects and at the same time evade the obnoxious purchase clause contained in the Tramways Act of 1870. Many schemes of the kind were brought to a successful issue until the local authorities became alarmed, and in the intervening years the opposition of the latter has frustrated any further attempts to build tramways under the Light Railways Act, except on tramway purchasing terms. Indeed, it now appears quite immaterial, excepting that private Bill procedure is more expensive, whether a tramway is submitted by private promoters under the Tramways Act or the Light Railways Act, as the local authorities also ask for the right of expropriation under the latter Act so as to equalise the position with the former. The applications made for light railway orders in the period mentioned were comparatively numerous, and for a considerable mileage of route, and if the presentation by private promoters of tramway schemes in the form of light railway proposals had not been arrested, it is probable that the development of tramways throughout the country would have proceeded more rapidly than has been the case down to the present time, provided that the permanency of tenure which formerly prevailed had continued, as the possession of lasting concessions would have facilitated the raising of the capital necessary for the execution of the works. As affairs stand at present, the total length of route miles of tramways and light railways in operation in the year 1912–13, as shown by the latest available return of the Board of Trade, amounted to 2662 miles, apart from 12 miles on the trackless trolley system. As the route mileage in 1911–12 totalled 2637 miles, it will be seen that the total addition made in a period of twelve months was only twenty-five miles, which is a comparatively insignificant expansion for tramways and light railways combined.

It is only occasionally that the annual reports of the Light Railway Commissioners give any indication of the actual mileage constructed under the Light Railways Act, the explanation probably lying in the circumstance that information concerning newly constructed lines does not reach the Commissioners promptly. However that may be, the latest figures are for as far back as the year 1910, when the Commissioners stated that 750 miles of light railways had been built, whilst a further mileage of 1200 had been authorised but not commenced. These figures naturally apply to all schemes which were promoted under the Light Railways Act ; they therefore include a number of tramways which were sanctioned in earlier years, and the actual mileage of lines already built, which in reality are light railways, can consequently not be determined. When referring in 1906 to the decline in the number of applications for orders, the Commissioners took the opportunity of stating that many of the proposed lines were necessary to admit of the progress, or even the maintenance, of existing trade interests—including fishing and the great industry of agriculture—to provide improved means of access in order to assist in retaining the population on the land, to counteract the remoteness of rural districts, and to cope with the difficulties as to housing and the supply of labour in the neighbourhood of industrial centres. These, then, are the objects which, in the opinion of the Commissioners, light railways should realise, and they have since frequently urged that greater facilities should be afforded for the construction of lines of this character, including the bringing of railless trolley lines within the scope of the Act. But the opposition of municipal and other local authorities prevented the realisation of this propos ' when suggested in the Light Railways Bill, which subsequently became the Act of 1912. The extent of light railway progress, including a number of tramways in the early days, in contemplation since the passing of the original Act in 1896, may be judged from the fact that the applications for orders have represented a route length of 4928 miles, whilst the lines submitted to the Board of Trade for confirmation down to the end of 1913 comprised a total length of 2148 miles, and an estimated expenditure of over £16,250,000. It is, however, highly improbable that the work of construction since 1910 has brought the total from the 750 miles of that time to one-half of the mileage in question, as confirmed by the Board of Trade down to the close of 1913.

It was only to be expected that the elimination of tramways from the Light Railways Act, at least in so far as promotions by private individuals or companies are concerned, should have caused a considerable decline in the number of applications made for orders in recent years, whilst at the same time the difficulty of floating the share capital for genuine light railways has also hampered the progress of construction. The financial assistance afforded by the Treasury is also rendered in a very economical manner, and is not calculated largely to advance the work. For instance, out of the £250,000 provided under the Act of 1896 for free grants or special advances over a period of five years, only the sum of £140,000 had been paid over after the lapse of fourteen years in connection with a total length of 68 miles, and only £35,000 had been advanced by way of loans out of the £750,000 which was assigned for this purpose in 1896. Since the end of 1910 special advances of £57,000 have been conditionally promised towards the construction of the proposed Mid-Flintshire light railway and the Fraserburgh and Rosehearty light railway, although the sum available to the Treasury for free grants and special advances has been increased to £750,000 under the Act of 1912. Some of the schemes are in suspense for several years, one now dating back to 1908 and two to the year 1909, and the question of Treasury assistance also seems to occupy attention for a few years before a decision is reached

by the responsible authorities. In the circumstances it is scarcely surprising that light railway progress proceeds in a very leisurely manner. During 1913 the number of orders confirmed by the Board of Trade was seven for a total length of six miles, and in the preceding year the orders numbered nine and the length twelve miles. Several of the applications for orders in 1912 proposed to secure the financial assistance of the Treasury and the local authorities concerned, but no aid from these sources is sought in the applications made last year, of which some, together with others from preceding years, are still awaiting a final decision.

## THE ROYAL SOCIETY'S CONVERSAZIONE.

ON Wednesday evening the Royal Society held the first of its annual conversaziones at Burlington House, and as usual there was a plentiful display of scientific exhibits. Among these, however, there were fewer of interest to the engineer than is customary. Many of them were of a botanical or zoological nature. The Piltdown skull has not yet been laid to rest, and a fresh reconstruction of it was shown by Mr. Pycraft, while Mr. Charles Dawson exhibited its lower canine tooth, which he discovered last August close to the spot where he made his first discovery in 1912. A selection of the specimens collected on the British Antarctic Expedition, under the leadership of the late Captain Scott, elsewhere attracted attention.

Many of the exhibits were curious rather than useful. In a corner of the library, Mr. Boys was to be found still struggling to demonstrate that "there is a great deal of science in a soap bubble." On this occasion his "rainbow cups" were neglected for the sake of a new piece of apparatus resembling a blowpipe, whereby soap bubbles up to 2ft. in diameter could be blown. In the Archives Room, Professor A. W. Bickerton exhibited the Polyscope, an instrument described by him as an optically perfect kaleidoscope. It is perhaps rash to imply that this scientific glorification of a child's toy is more curious than useful. The patterns it produces are extremely beautiful and varied, and are geometrically accurate and symmetrical. By projecting them it seems possible to employ them for suggesting new designs for dress materials, wall papers, linoleums, carpets, ornamental tiles, &c.

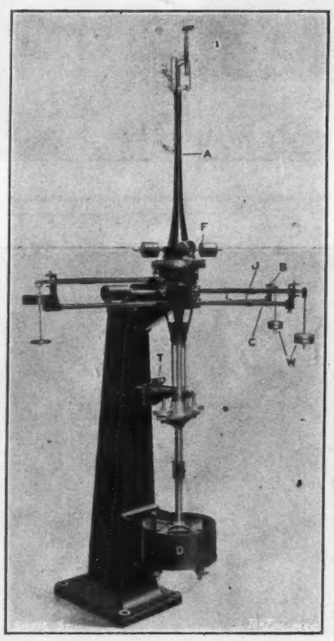
Of the exhibits more directly interesting to the engineer, we may mention first the aerodynamic balance shown by the Cambridge Scientific Instrument Company, Limited, an illustration of which is given in the attached engraving. The actual instrument shown has been constructed for the Massachusetts Institute of Technology, Boston, and is a copy of those originally designed by the staff of the National Physical Laboratory for the experimental investigation of the stability of aeroplanes. The main part of the balance consists of three arms A, B and C mutually at right angles, each arm being counterbalanced. The centre lines of these arms meet in a point at which a steel centre is fixed. The weight of the balance is taken on this point, which rests in a hollow cone on a column from the floor. The vertical arm A of the balance passes through the underside of a wind channel, and supports the model under test. The horizontal arms are set parallel and at right angles to the wind direction. The arrangements allow of the measurement of the forces on the model along three fixed rectangular axes, and also of moments about these axes. The model can be rotated about two axes at right angles to the wind direction and to each other, so that determinations of lift and drift and of the couples acting on the aerofoil may be made for any angle of incidence of the wind. The forces on the model are counterbalanced by weights W hung from the ends of the horizontal arms, fine adjustment being provided by the movement of jockey weights J along the arms. The rotation of the balance about the vertical axis is prevented by a torsion wire, the twist on which is measured on a torsion head T. The force along the vertical axis is measured by a horizontal weighing lever, the force on the model being transmitted to the lever through a vertical rod which slides freely inside the vertical arm of the balance.

Rapid oscillations are damped out by dashpots. The largest of these, D, is fixed to an extension of the vertical arm below the point of support and damps the motion of the three principal arms of the balance in all directions. On the lower part of the vertical arm weights can be placed, which permit changes to be made quickly in the sensitivity of the balance. Four balance weights F are provided by means of which the centre of gravity of the rotating part of the vertical arm and the model attached to it can be arranged to lie in the axis of rotation. Of the six force and couple measurements necessary for the examination of the most unsymmetrically situated model, it is possible to make four simultaneously. Except in special circumstances, this is not attempted, however, and locking arrangements are provided which reduce the number of degrees of freedom as desired. For the purpose of fixing a definite position of the beams, cross wires are attached opposite each beam, and these are observed, in order to avoid parallax, against lines ruled on mirrors attached to each balance arm. The line is made on the mirror surface and the beam is in its equilibrium position when this line is midway between the cross wire and its image, whatever the position of the observer's eye.

Dr. Vaughan Cornish showed some photographs illustrative of landslides and upheavals on the Panama Canal. The photographs were taken in 1910, 1912 and 1914. One, of the Culebra Cut in 1910, showed an upheaval of the solid rock of the Canal bottom, due to unbalanced pressure of the banks. Another, of the Naos I. breakwater, taken in 1912, showed the upheaval of the sea bottom at a distance from the subsiding mass of the breakwater. Some photographs of the Cucuracha slide, in 1914, showed the downward flow of inclined strata. The ground was shown to be broken for a height of 580ft. above Canal bottom.

Some specimens and photomicrographs of electro-deposited lead, showing the effect of varying current density, temperature, and the addition of organic salts, were exhibited by Mr. S. Cowper-Coles. The experiments were undertaken for the purpose of determining what were the essential conditions for obtaining electrolytically thick deposits of metallic lead in a coherent form free from nodules and trees.

A very interesting water model of the electric arc was demonstrated by Mr. W. Duddell, F.R.S. One of the essential properties of the electric arc, as is well known, is that, when the current through the arc increases, the potential difference between its terminals decreases. The model exhibited consisted of a mushroom valve. The pressure tending to reseat the valve was so arranged that it diminished very rapidly as the valve lifted. In this way, when the flow of water was increased through the valve, the




AERODYNAMIC BALANCE

difference of pressure between its two sides decreased, and thus represented one of the properties of the electric arc. When a steady flow was established and a column of water having a definite periodic time was connected to the valve, oscillations could be set up similar to those obtained with an electric arc. Other properties of the arc discharge can also be demonstrated by means of this model.

Mr. W. A. Douglas Rudge demonstrated experimentally the electrification produced during the raising of a cloud of dust. During the raising of a cloud of dust by almost any method, considerable charges of electricity are, it seems, produced. A charge of one sign is found upon the dust itself, and another charge of opposite sign, either upon the air, or else upon fine particles of dust which remain suspended in the air. Generally, dust of an acidic nature, such as silica or molybdic acid, give a negative charge to the air, while metallic oxides and organic bases give positive charges to the air.

Dr. T. E. Stanton, F.R.S., of the National Physical Laboratory, exhibited some experimental apparatus for illustrating mechanical viscosity, and the shearing stress due to eddy formation in fluids. In this, a current of water was passed through a cylindrical brass pipe provided with a manometer for measuring the fall of pressure due to friction over a given part of its length. Arrangements were provided for heating the water entering the pipe and for maintaining the rate of flow constant. The rate of flow was set at a value slightly less than the critical velocity, and by heating the water and reducing its viscosity, eddy formation was made to begin, and the shearing stress was considerably augmented.

Dr. Stanton also showed some experimental apparatus for illustrating the relation between surface friction in fluids and the convection of heat by them. A current of air whose rate of flow could be regulated within wide limits was passed through a brass pipe, the internal surface of which could be maintained at a desired temperature. The temperature of the air emerging from the pipe was indicated by an air thermometer. By keeping the surface temperature of the pipe and the initial temperature of the air constant, it was shown that the final temperature was nearly constant for all rates of flow above the critical velocity.

The Hon. R. C. Parsons exhibited his chemical ejectors. These are instruments for automatically mixing in definite proportions one liquid with another. The "Tiltometer" is a form of injector for mixing liquids which are under a pressure of a few feet only, and the "Senfrot" high-pressure injector is one capable of mixing liquids under any pressure. We published a description of the "Tiltometer" in our issue of March 29th, 1912.

The transparency of the surface film produced on copper by polishing was demonstrated by Dr. G. T. Beilby, F.R.S., by means of specimens under microscopes showing surfaces on which minute concave pits had been covered with a transparent film of the metal in the vitreous amorphous condition.

Dr. W. Rosenhain, F.R.S., of the National Physical Laboratory, showed an apparatus for mounting micro-sections of metals at right angles to the optic axis of the microscope, and exhibited a new reagent for etching mild steel for microscopic examination. This reagent consists of an acid solution of ferric chloride containing small proportions of chlorides of copper and tin.

Some extremely interesting surface tension phenomena were shown under optical projection by Mr. C. R. Darling. In one of these a globule of oil was formed on the surface of water, and a drop of quinoline allowed to fall upon it. On this drop reaching the oil-water interface, the globule was burst with considerable violence. In another, orthotoluidine globules were formed on a water surface, and a large globule of dimethyl-aniline added, which then proceeded to absorb the orthotoluidine. The process of absorption resembled the feeding of certain lower organisms.

Some very beautiful instantaneous photographs on paper taken in natural colour by the Polychromide system were shown by the Polychromide Company. The optical separation of the natural colour of the object photographed is accomplished in this process by means of the Hamburger-Conrady colour separation camera, which exposes three plates simultaneously—representing the red, yellow and blue sensations in the superposed positives on gelatino-silver emulsions.

## LITERATURE.

*The Sampling and Assay of the Precious Metals.* By Ernest A. Smith, Assoc. R.S.M. Pages, 9in. by 6in., xv. and 460; also 166 illustrations. Charles Griffin and Co., Limited. Cloth 15s. net.

THIS is scarcely a subject that we can regard as likely to appeal to many of our readers, even although we add the supplementary statement contained on the title page, "comprising gold, silver, platinum, and the platinum group of metals in ores, bullion, and products," and for this reason we do not intend to give it the full notice it deserves. It is, however, of interest as being one of the series of treatises on mining and metallurgy emanating from alumni of the Royal School of Mines started by the late Sir William Chandler Roberts-Austen and published by Charles Griffin and Co., Limited. All these publications have displayed a high level of merit; some of them, indeed, are regarded as the standard text-books in the subjects upon which they treat. The author of the present volume deals with quite a small but select branch of metallurgical industry; it is, however, of very considerable importance, exercising a remarkable and controlling influence over the very springs of the commerce of the world; it may, indeed, be regarded as of the patrician class, if such can be, of industrial pursuits. However important it may be, there are very few who would not feel convinced that such a subject could certainly be disposed of in comparatively few pages of large and well-spaced type. But such is not the case in the present volume, for the type is small, the lines are long, and close together, and the pages are large and many; in fact, it is a subject that has received considerably more consideration than has ever been supposed; hence the author has done a really useful service in bringing all this information together in the present volume. The contents comprise:—The design and equipment of assay offices; assay furnaces, implements, and apparatus; modes of sampling, materials, methods, and refinements of these special assays; their application in general practice at the mine and in the cyanide mill; the properties of the metals concerned. It is pleasing to note that the work has been done with a conscientious thoroughness and precision which recalls the work of that giant among metallurgists, Dr. Percy, with whom, moreover, the author's father was inseparably associated in the metallurgical laboratory of the Royal School of Mines.

# NEW BOILERS AND COAL-HANDLING PLANT AT SOUTHEND

(*For description see opposite page*)

Fig. 1—COAL HOPPER AND ELEVATOR

Fig. 2—OVERHEAD COAL BUNKERS

Fig. 3—NICLAUSSE BOILERS AND STOKERS

## NEW BOILERS AND COAL-HANDLING PLANT AT SOUTHEND.

WE were invited to visit Southend on Friday of last week in order to inspect a battery of two Niclausse boilers which have recently been installed at the electricity works there by the British Niclausse Boiler Company, Limited, of Caxton House, Westminster, S.W. In the engine-room at this works the main generating plant consists of four Belliss, two Willans, and one Howden engines driving direct-current dynamos, all of 500-kilowatt capacity and these two sets of boilers had to be placed beside them and not at the back, as in the Niclausse boilers. The economisers in the latter consist, we may say, of 192 tubes 9ft. long.

We have so lately described a Niclausse boiler—see our issue of March 13th last—that it will not be necessary to go again into its general construction, for though the boiler described in that issue was of the marine type, the construction of the tubes and headers in both types of boilers is practically identical. But, whereas the marine type boiler was oil fired, the Southend boilers are coal fired and escape unburnt into the flues, finds its way down into hoppers underneath the boiler, whence it can be removed and utilised.

The fire-bar bearers are, as has been intimated above, capable of longitudinal motion. The movement is effected by means of a slowly rotating shaft provided with hard steel trip pieces which engage with steel blocks mounted on the bearer heads. The effect of these is to reciprocate the bars in given rotation. In coming forward towards the front of the boiler no two adjacent bars move at the same time. If, say, No. 1 starts first, No. 3 will move

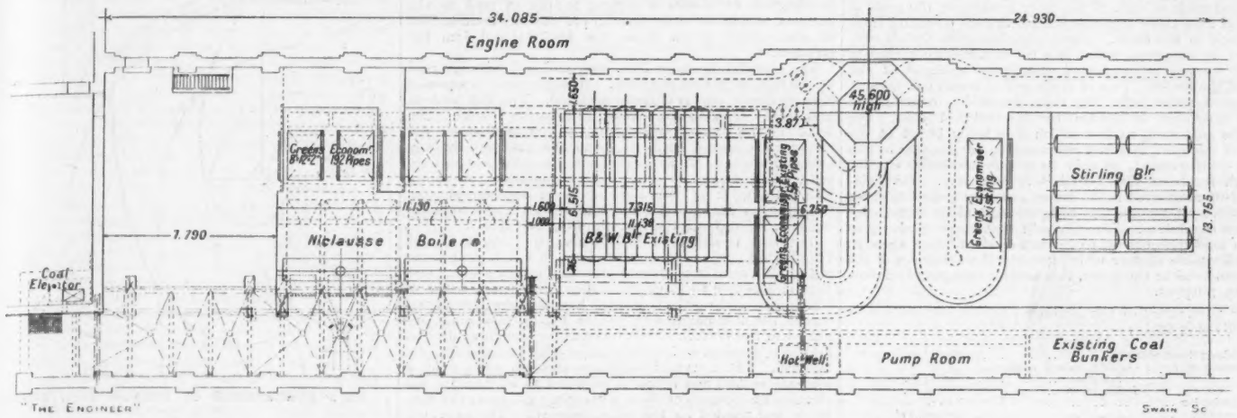



Fig. 4—PLAN OF BOILER-HOUSE, SOUTHEND-ON-SEA ELECTRIC GENERATING STATION

all exhausting into a very large Ledward and Beckett evaporative condenser, which was described in our issue of 23rd April, 1909. In the boiler-house, before the new boilers were put in, there were three Paxman Economic, two Babcock and Wilcox, and two Stirling boilers. The two new boilers have taken the place of the three Paxman boilers. We are given to understand that when working to their full capacity the Stirling boilers will each evaporate 10,000 lb. of water per hour, and the are provided with Niclausse grates and mechanical stokers. We may therefore usefully refer to these. The coal is fed down three shoots from overhead coal bunkers into three hoppers feeding the three sections of grate into which the boiler is divided in its width. Fig. 5 shows a longitudinal section through the boiler and its economiser. It will be observed that the grate is set with a slope backwards and downwards of about 10 deg. The fuel is fed in from the hoppers through an aperture, the opening next, then No. 2, then No. 4, and so on. In going back, however, the order is No. 1, No. 2, No. 3, and so on. The result of this reciprocating motion, combined with the angle at which the bars are set, causes the fuel gradually to be carried to the rear of the furnace, and when the clinker has arrived at the end of the grate it is discharged over the end into a shoot running down to a hopper, whence it can be removed in trucks. There is, it will be understood, one such shoot and hopper to each section of the

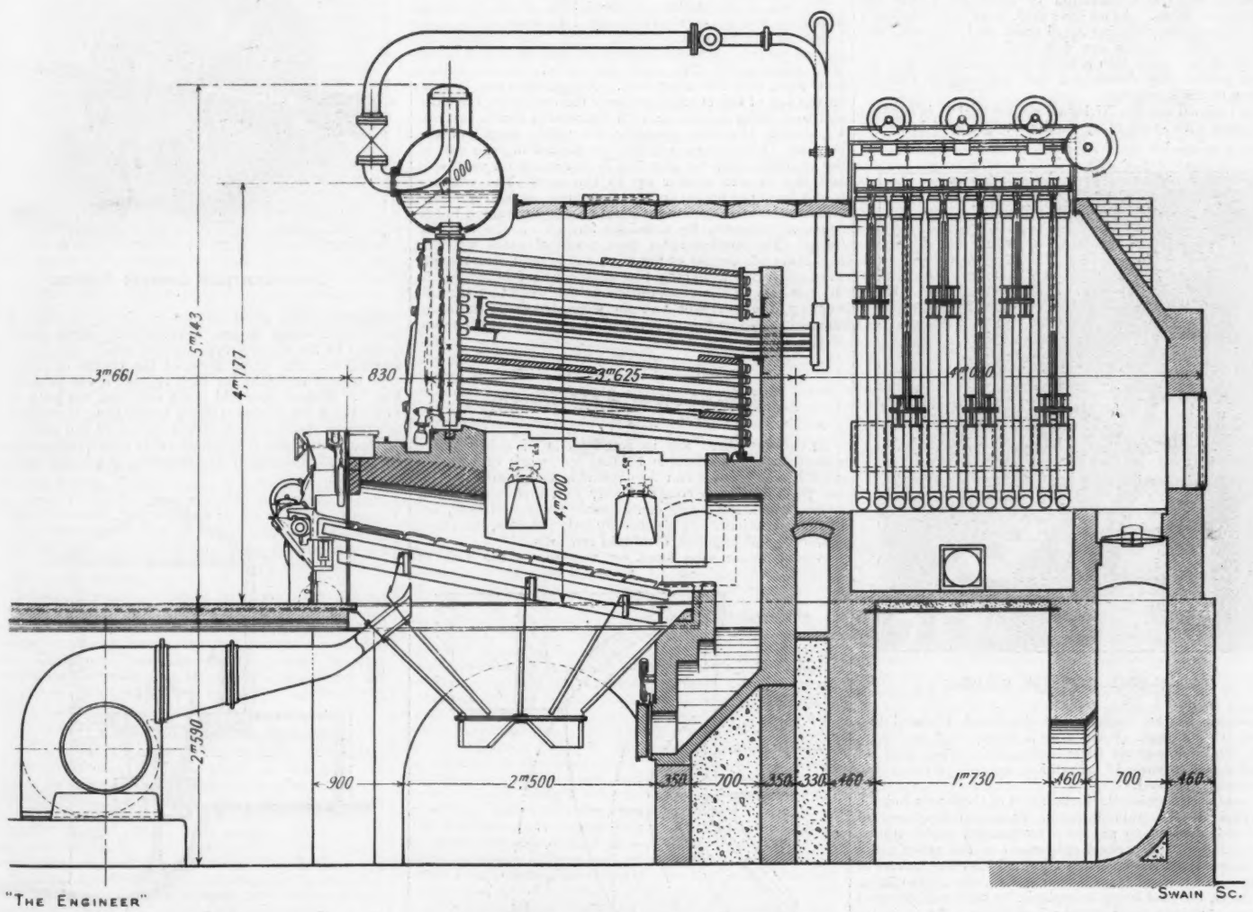



Fig. 5—LONGITUDINAL SECTION OF NICLAUSSE BOILER

Babcock boilers each 12,000 lb. of water. When working at normal draught the Niclausse boilers are each rated to evaporate 25,000 lb. of water and to evaporate at overload 35,000 lb. of water each, these figures all being from and at 212 deg. Fah.

The two boilers occupy a floor space 36ft. 6in. wide by 15ft. 6in. deep. The relative space occupied by the three types of boilers with their economisers will be observed in Fig. 4, and it may be remarked that it was necessary to provide the space in front of the Babcock and Stirling boilers in order to allow for the withdrawal of the tubes and the chain grate stokers, so that the economisers for of which can be regulated from nothing up to some 10in. deep by the boiler attendant. Each section of the furnace comprises a number of bearers carrying the fire-bars, which are made up in sections about a foot long and arranged five abreast, the combined width of the five bars being about 3¼in. The bearers are so set that these compound fire-bars come quite close together, but not so close that they cannot move longitudinally relative to one another, or so that fine coal dust cannot pass between them. Indeed, the thin fire-bars themselves are cast with slight projections so that dust can even pass between them, and this dust and fine coal, which might otherwise perhaps grate. The reciprocation of the fire-bars has the further effect of preventing the formation of clinker of any great size. In watching the action of the grate through the peep holes it could be seen that the clinker is all broken up into quite small pieces; indeed, the motion of the bars is such that no big pieces of clinker are formed. An examination of the clinker showed that it was exceedingly well burnt. Before the clinker reaches the end of the grate the fine ashes have passed down through the fire-bars into a fine ash hopper just as did the fine coal before combustion had taken place.

The speed of the rotary shaft of the stoker can be varied

between one and six revolutions per minute by means of change gears of very much the same nature as those employed for motor cars or machine tools. Moreover, speeds intermediate between these can be obtained by regulating the speed of the small electric motor which drives the mechanism.

The draught for the boilers is supplied from beneath the grates by means of an electrically driven fan. At the time of our inspection the boiler was working light and the draught was not more than that represented by ¼in. of water. We are informed that at full power normal working not more than from ⅜in. to ½in. is required. The underside of each of the three sections of the grate is divided into three separate compartments counting from the back to the front. These compartments are all controlled by dampers, which can be adjusted by means of levers worked in graduated quadrants arranged at the side of the boiler. Two of these sets of levers can be seen in Fig. 3, page 542. The third set, which controls the front chamber, is hidden by the vertical joist. For volatile coal such as that which was being burnt at the time of our visit, it is not necessary to use draught in this front compartment, or only to a very moderate extent, though for hard Welsh coal it is necessary. The compartment most used is the second, and we gather that for all ordinary purposes this compartment alone suffices for general regulation. We may add that there is also provision for supplying air to the top of the furnace through the adjustable shutter which governs the thickness of the coal delivered to the grate, this shutter being made hollow for the purpose.

The particulars of the Niclausse boilers are set out in the following table :—

| | |
|---|---|
| Working steam pressure | 160 lb. per sq. in.* |
| Heating surface : Outside tubes, neglecting headers | 3700 sq. ft. |
| Inside tubes | 1700 sq. ft. |
| Superheater | 1076 sq. ft. |
| Superheat | 150 deg. Fah. |
| Tubes : Diameter | 80 mm. = 3.15in. |
| Length | 10ft. 1¼in. |
| Headers (each having 21 evaporating tubes and one cleaning tube plug) | 20 |
| Steam drum : Diameter | 3ft. 3⅜in. |
| Length | 17ft. 1¼in. |
| Thermal efficiency | 80 per cent. |

* We are informed that the boilers were built for a working pressure of 225 lb. per square inch, and were tested to 360 lb. per square inch.

The new boilers have, unlike the older boilers in the station, been set so that the firing floor is level with the yard and with the adjacent engine-room. This lifting of the boiler has had the effect of allowing the main flue to be arranged under the economisers and of providing sufficient headroom for the installation of excellent means for handling the ashes. As we have said, there are under each grate hoppers for catching small green fuel, fine ash, and clinkers. The clinkers are delivered continuously over the end of the grate into a brick-lined chamber, and are thence periodically discharged into ash wagons running on lines in the basement.

It is claimed for the Niclausse stoker that it is capable of burning with satisfactory results any grade of fuel from

Fig. 6—COAL CONVEYOR GALLERY

the richest to the poorest. At Southend, Midland fuel having 42 per cent. of volatiles is being used, whilst in South Wales low-grade fuels having only 9 per cent. of volatiles and 30 per cent. of ash are, we understand, being successfully handled.

In conjunction with the installation of these new boilers, Mr. Birkett, the able Borough Electrical Engineer of Southend, decided to put in a mechanical coal-handling plant. Before the present extensions to the boiler plant were carried out the coal was trimmed into the stokers of the boilers by hand from a coal store built on the firing floor level, the coal being brought in by carts and dumped into the bunkers from a raised platform. As it is his intention at some future date to dispense with the two older water-tube boilers to which we have referred, and to install three others of a later type, thus making a complete range of five boilers, the coal-handling plant had to be arranged so that it would serve the complete range of five boilers without any structural alterations. The plant was put out to public tender and several firms submitted schemes. Among the firms which tendered was Ed. Bennis and Co., Limited, of Little Hulton, Bolton. This company put forward five or six schemes, of which one was accepted. This involved the building of overhead storage bunkers with a capacity of about 300 tons of coal and the raising of the fuel into the bunkers by a bucket elevator, which would deliver it into a distributing conveyor passing over the top of the bunkers. In order to obtain the required amount of storage it was necessary to cut away a considerable portion of the roof and make other arrangements for supporting it without disturbing the remaining portion of the roof. This meant cutting eight of the main roof principals in such a way as to avoid lessening the strength of the roof.

The coal is brought up in carts or trucks and dumped into the receiving hopper excavated below the ground level outside the boiler-house, as may be seen in Fig. 1, page 542. The coal flows by gravity from this hopper into the elevator through a Bennis rotary safety feeder, which is designed to ensure a regular supply of coal to the buckets, and at the same time to prevent any sudden rush of coal which would choke the buckets and jam the elevator.

The elevator is about 70ft. long and will raise the coal at the rate of 20 tons per hour. It is driven by a separate electric motor and is entirely enclosed. The full buckets and empty buckets are encased in separate trunks. The whole of the gearing and shoots, &c., is carried on the elevator framework so as to avoid the necessity for any external bearings or supports, and to form an entirely self-contained machine occupying a minimum of room. The framework of the elevator is of substantial construction, so that no intermediate supports are required between the top and the bottom of the elevator.

The coal is delivered by the elevator into a Bennis U-link steel chain conveyor, the links of which are formed out of mild steel bars pressed into the form of a "U," and riveted together to form an endless chain, one strand of which moves along the bottom of a rectangular trough and carries the coal along with it—see Fig. 6. Openings are placed in the bottom of the rectangular trough at desired intervals, through which the coal may fall into the bunkers beneath. The conveyor is driven through gearing by a separate motor, and access is obtained to all parts of the elevator and conveyor from a gangway alongside the conveyor and carried on the same supports. The conveyor has, like the elevator, a capacity of 20 tons of coal per hour.

The bunkers are built out of mild steel plates and sections riveted together to form a series of rectangular bins with hoppered bottoms. A number of openings are placed at the bottom of each bin, each opening being provided with an outlet shoot and radial cut-off valve operated by chains by the attendant standing on the firing floor line—see Fig. 3. A swing shoot, with hoppered top and bell-mouth delivery, is suspended beneath each outlet for guiding the coal from the bunkers to the stoker hoppers. These shoots are made to swing back out of the way when the tubes of the boilers are being cleaned or renewed.

The top of the bunkers is about 39ft. above the firing floor level and the vertical sides are 11ft. deep. The total length of the bunkers is about 106ft. The bunkers are carried entirely on twelve stanchions formed out of rolled steel joists about 27ft. long, resting on concrete pillars built level with the firing floor. A superstructure is built on the top of the bunkers to carry the conveyor, the sides and roof being sheeted in with corrugated sheets to form a conveyor chamber extending the whole length of the bunkers. Continuous windows are placed in each side of the chamber and the sheeting is continued on each side and end of the bunker up to the roof. The extreme height from the bottom of the stanchions to the top of the superstructure is about 56ft., and access is obtained to the conveyor chamber by a ladder formed on the elevator frame. The bunker sides were made of extra strength to sustain the weight of the roof, and special attachments were made for attaching the modified roof principals to the bunkers so that, in addition to the weight of the full bunkers, the conveyor and the superstructure, the stanchions have to sustain the weight of a considerable portion of the boiler-house roof.

## A LOW-HEAD WATER TURBINE.

ALTHOUGH there are in some parts of this country waterfalls of considerable height, by means of which a good head of water can be obtained, the greater part of the British Isles is comparatively flat, and most of our rivers, which have any considerable volume of flow, are of slight gradient. It is generally only possible, therefore, without great expense, to obtain low falls.

Among those who have set themselves the task of

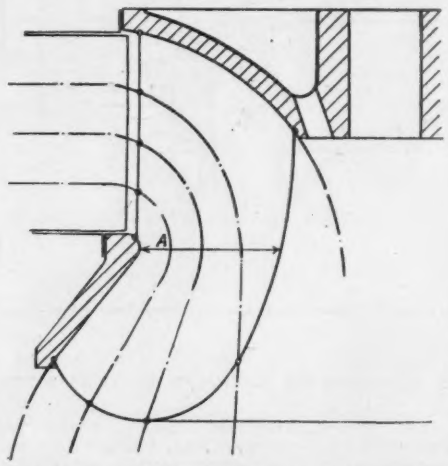



Fig. 1—USUAL PROFILE OF FRANCIS TYPE RUNNER

introducing turbines by means of which these low falls can be effectively made use of for power purposes are Joseph J. Armfield and Co., of Ringwood, Hants. This firm has installed numerous successful turbine plants of this character throughout the country, and has just recently introduced an improvement in turbine runners of the Francis type, for which considerable advantages over anything previously in operation are claimed, among the chief of these being that lower falls of water can now be made use of than has hitherto been the case. Up to the present the large size, and hence the high cost, both of the turbines themselves and of the flume or other river works to accommodate them, has rendered falls of less than about 5ft. rarely worth development for power purposes. In the case of the first of the new type of turbine introduced by

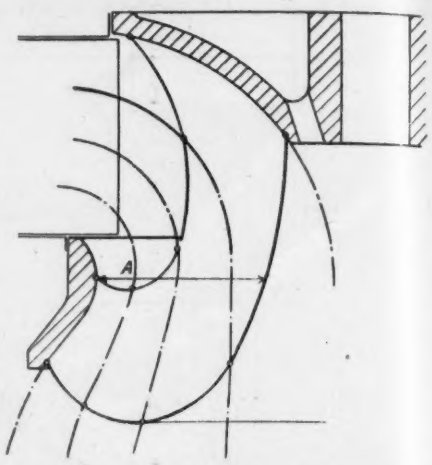



Fig. 2—NEW PROFILE OF FRANCIS TYPE RUNNER

Messrs. Armfield, which has been put to work on a branch of the Test at Longparish, in Hampshire, the fall is only 3ft., and the turbine has been designed to develop 12 horse-power.

The requirement with such low falls and powers as these, in order to keep the cost low, is for the smallest possible turbine and the highest possible speed, in relation to the velocity of the water, for a given capacity, which is

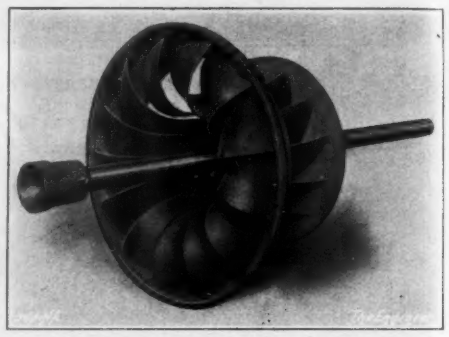


Fig. 3—ARMFIELD TURBINE RUNNER

compatible with good efficiency. It is to meet these requirements that Messrs. Armfield have made the modification in the Francis type runner which have just been alluded to. The usual form of the profile of a Francis type runner designed for high specific speed is shown in Fig. 1. Messrs. Armfield point out that the path of the water upon the blades is much longer than is required for the proper development of the curves of the blade, and, further, that there is a considerable contraction and subsequent enlargement of the waterway in passing the plane

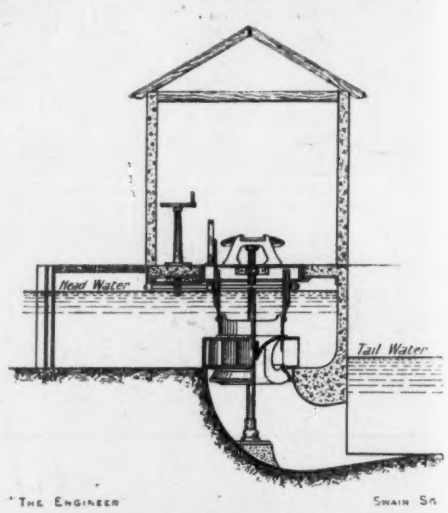



Fig. 4—SECTION THROUGH TURBINE HOUSE

of the initial edge of the lower boundary of the wheel A, where the flow lines have also their greatest curvature. They further point out that, in consequence of this, in the ordinary Francis type runner, the flow at high velocities becomes unsteady at this point, and that, consequently, losses due to friction and eddies ensue. They urge that in order further to increase the relative velocity of the water, without loss of efficiency, it is necessary to eliminate these features, which are otherwise the limiting factors, and are actually interdependent.

With this object in view they have designed and patented the profile blade form shown in Fig. 2, and by it they claim that the relative speed of the wheel can be very considerably increased, while the efficiency is maintained or even heightened.

The first wheel of this type is, as we have said, installed at Longparish, and there we have had an opportunity of seeing it in operation. Its runner, which is shown in Fig. 3, has a minimum diameter of 30in., and runs, when working at full speed, at 93 revolutions per minute. It was designed for a horse-power of 12, and on test on the brake it developed something in excess of 13 horse-power. Messrs. Armfield point out that in previous modern practice it would have been necessary, in order to obtain 12 horse-power, to install a turbine of some 38in. in diameter running at about 70 revolutions per minute.

The turbine, as will be seen from Fig. 4, is fixed in an open forebay, and the water is discharged through a draught tube formed in the concrete foundations. The unrecovered velocity of the water is given as being about 4 per cent. Some little difficulty has been experienced in measuring accurately the flow of water passing through the turbine, but Messrs. Armfield inform us that they have taken numerous tests and readings by different methods, and that these have shown a fairly close agreement in indicating a full gate efficiency of some 81 per cent. and a three-quarter gate efficiency of 83 per cent. These figures, if accurate, and Messrs. Armfield are confident that they are, are remarkably good for a small plant of this kind, and would appear to open up the possibility of using successfully low falls which have hitherto been regarded as quite useless for power purposes.

In the present instance the power is transmitted from the upright shaft of the turbine to a horizontal shaft by means of a pair of morticed wood and iron toothed bevel wheels which run with but little noise. From the horizontal shaft a dynamo is driven by means of a pulley and belt. The dynamo is used for charging a battery of accumulators which is situated some few hundred yards from the turbine house.

## THE ROYAL COMMISSION ON RAILWAYS.

### No. XII.*

AT the sitting of the Royal Commission on Thursday afternoon, the 7th inst., at which all the members of the Commission were present, three witnesses were heard.

### COMPLAINTS OF SEASON TICKET HOLDERS.

The first was Mr. G. W. Flood, who expressed the grievances of season ticket holders in the London area as to overcrowding, excessive fares for some districts when compared with others, &c. The associations he represented thought that the Board of Trade had no interest in the ordinary passenger, and they wanted a Traffic Administration Board to hear complaints and enforce remedies. If rates were too high the Board should have power to secure a reduction. When Mr. Shackleton pointed out that this would interfere with the railway company's legislative powers witness said he had not recognised that fact. He would be willing to pay a fee for hearing complaints.

### COMMERCIAL TRAVELLERS.

Mr. L. R. Stoakes, who proved an excellent witness, appeared on behalf of a body of 370 commercial travellers. He said that in his profession the best customers got the best attention, but, although the commercial traveller paid full fare and trade resulted from his journeys, so making the commercial traveller the railway's best customer, he got no consideration. Witness quoted some apparent anomalies in season ticket rates and conditions, and showed that, while a trader got a rebate on his season ticket if he put £300 worth of traffic a year on the railway, the traveller got no rebate, as in nearly every instance it was the customer who paid carriage. He wanted 1000-mile ticket books, as on the North-Eastern Railway. Travellers did not get the same amount of luggage carried free when travelling third as they did if going second or first. When the Brighton Company abolished second class many travellers had to go first to secure the extra allowance of luggage, and it was felt that the first-class fares should have been lowered. An increase in the rates for excess luggage was threatened, and when complaint was made to the Board of Trade it was said that the companies did not recognise the right of the Board to interfere, as the carrying of luggage was a privilege.

Mr. Stoakes brought forward a new point against nationalisation, and was thanked by the Chairman for drawing his attention to it. The witness said that nationalisation would, it was expected, lead to a reduction in fares. This would permit people more readily to visit the centres, and so trade would in time be taken from the smaller places. This would not be to the benefit of the country.

### WORKMEN'S TRAINS.

Mr. George Dew, a member of the Housing Committee of the London County Council, spoke on behalf of the Association for Workmen's Trains, which wanted an amendment of the Cheap Trains Act of 1883. Witness gave the following particulars as to workmen's trains run daily :—Metropolitan District, 235; Metropolitan, 166; South-Eastern and Chatham, 175; Brighton, 122; London and South-Western, 98; Great Eastern, 116; London and North-Western, 45; Midland, 44 (was 14 until the company absorbed the Tilbury); Great Western, 29; Great Central, 19; Great Northern, 16. He would have cheap trains run to districts to encourage traffic. Witness recognised the difficulties, but the number of trains might be small at first and grow as the population increased. In reply to an inquiry from Lord Loreburn, Mr. Dew said that possibly the municipal authorities might assist with a grant or give a guarantee—he could see no difficulty in that.

The best plan was to get clauses ordering workmen's trains to be put in Bills. Witness gave some instances where this had been done, and said that Parliament evidently recognised that 2d. per day, or 1s. per week, should be the maximum return fare, as this was the sum named in the various Acts containing clauses for workmen's trains. An amendment in the 1883 Act that was wanted was that it said "to arrive before 8 a.m.," whereas the companies generally issued tickets up to this hour. The Act also said, "to return after 6 p.m.," which was not a restriction now enforced.

The London and North-Western gave a good service to Watford, and the South-Eastern and Chatham issued tickets for a radius of 20 miles not only into London, but out of it. All railways should be compelled to issue workmen's fares at 20 miles for 4d., 16 miles for 3d., and 12 miles for 2d.; this not only in London, but in all large cities. If this were done at a loss the remainder of the passenger duty should be taken off. He did not think that there should be a duty on locomotion.

* No. XI. appeared May 8th.

### THE RAILWAY NATIONALISATION SOCIETY.

The following day (Friday) the only witness was Mr. Emil Davies, chairman of the Railway Nationalisation Society, who read a memorandum he had prepared on the subject and was subsequently examined thereon. Railways, it was claimed, were one of the services that are essential to every branch of trade and commercial activity, and should be operated primarily to serve these ends, and only secondarily, if at all, for revenue-producing purposes. As it was in the interest of the national well-being to render road transport as cheap as possible and to carry correspondence and parcels at the minimum rates, so it was in the national interest to facilitate to the utmost the interchange of commodities between different parts of the country and foreign countries, to open up backward districts, to facilitate the obtaining of employment and to promote social intercourse by providing the cheapest possible transport of persons, goods, and produce of all kinds.

Board of Trade Return No. 287 of August, 1913, showed that there was a total of 134,403 miles operated by State administrations and 367,675 by private enterprise. Included in the latter were the 249,902 miles, or 68 per cent. of the whole, in the United States. In the United States, Mr. Davies claimed, Government ownership was a leading question; a physical valuation was being made by the Government of all the railroad properties, and the railroad in Alaska was to be built and operated by the State.

After reference to the course of events since 1907 and the closer relations between English and Scottish companies, the witness quoted from Mr. (now Sir) Kaye-Butterworth's memorandum to the Board of Trade Railway Conference. The quotation ended thus :—"With the best will in the world two minds or sets of minds cannot work as harmoniously and promptly as one, and no one will be likely to suggest that it can be otherwise than beneficial from every point of view that the route from Penzance to Paddington should be in one hand instead of four hands." This is a distance of 301 miles, yet, Mr. Davies pointed out, from London to Darlington is 232 miles on a direct route and forms part of two companies' system. He also gave other examples.

Uniformity in ordinary fares, season tickets, and workmen's fares would, it was expected, be secured under a national railway system. Excursion fares were not viewed with favour, as "the running of exceptionally cheap half-day or whole-day excursions on certain days was one of the uneconomic methods adopted by the British railway companies whereby the ordinary passenger was penalised for the occasional holiday maker.

On the subject of goods rates Mr. Davies observed that, after making full allowance for all differences in services rendered, the rates charged by British railway companies were much in excess of those on the State-owned railways of other countries. A no less important matter than cheaper goods rates was the lack of order in connection with the rates charged by the British railway companies. Under a State unified system some semblance of order could be brought into this system of goods rates. The German State Railways were not free from a number of special rates, but the system there, and under most other State-owned systems, was simplicity compared with the hundreds of millions of different rates of the British railway companies. With a national unified system return, season, and similar tickets could be utilised by anyone by any alternative route without any loss to the railways and with much gain to the passenger. Mr. Davies pointed out that the interchangeability which prevailed at the time of the coal strike in March, 1912, was carried into effect as a matter of course on every State-owned railway system.

After making what appeared to us a doubtful point, viz., that nationalisation would lead to uniformity in rolling stock, and therefore lead to greater safety to employees and the travelling public, the witness said that so long as the railway system was worked by companies organised primarily for the purpose of earning profits for their shareholders, the first duty of each company's management was towards its shareholders, and, with the best intentions in the world, such management could not conduct the business of transportation as a national service in the same way as it could if it were a State-owned service like the Post-office, whose first consideration was the interests of the community. Mr. Davies then pointed out that with State-owned railways there would be an annual railway budget before Parliament which would provide an opportunity for airing grievances.

In concluding his memorandum, Mr. Davies said that his society thought it right to add that, in its opinion, it would be wrong to raise any extravagant hopes of huge profits from nationalisation. It was not reasonable to assume that rates and fares could be reduced and the conditions of the workers improved, as would, in its opinion, inevitably result from nationalisation, and at the same time produce huge profits. It was, however, its considered opinion that the large financial saving to be effected by utilising the better credit of the State not only to purchase existing systems, but also to provide the capital necessary for extensions, electrification, &c., at a considerably lower rate than that which had to be borne by the railway undertakings under the present company system, combined with general good financial methods and the large savings to be effected by a reorganisation of general management, would provide a considerable margin to meet the cost of the price reductions and improvements in the conditions of labour referred to, and that such additional facilities would largely stimulate traffic and be beneficial to the whole country without throwing any burden upon the community.

In examining the witness as to the physical valuation of railways, Mr. Balfour said that he was in Washington recently, and was then told that the valuation now proceeding in the United States would occupy from 1500 to 2000 people ten years, and such changes would occur in that period that they would then have to start again. Asked as to the terms proposed for purchase, Mr. Davies said that his society's Railway Nationalisation Bill proposed twenty years' purchase on the average receipts for the last three years. He then gave the following table showing the figures for purchasing five typical British railways under three sets of terms :—(*a*) At their market value on February 28th last; (*b*) at twenty years' purchase; (*c*) at twenty-five years' purchase.

| | (*a*) At the market price February 28th, 1914. | (*b*) At twenty years' purchase. | (*c*) At twenty-five years' purchase. |
|---|---|---|---|
| London and North-Western | 123 millions | 122 millions | 154 millions |
| North-Eastern | 86 „ | 82 „ | 102 „ |
| Great Eastern | 50 „ | 44½ „ | 55½ „ |
| London, Brighton | 34 „ | 30 „ | 35 „ |
| London, Chatham and Dover | 52 „ | 44 „ | 55 „ |

Mr. Davies told Sir Frederick Upcott that he was prepared to be confronted with the fact that witnesses from Chambers of Commerce had been against nationalisation, but he considered that these Chambers were not representative, and he pointed out how on the agenda of the annual meeting of the Associated Chambers of Commerce there were four complaints against railways, and that the only reference to the Post-office was in terms of praise. In answer to Mr. Shackleton, the witness said that railway servants were so organised that they brought political pressure to bear now, and it could be no worse under the State. Sir William Plender, asking how many members were in the Nationalisation Society, was told that it had 300 individual members, and 200 co-operative societies and trades unions, which have a membership of over half a million, all of which had passed resolutions in favour of nationalisation. Mr. Davies told Sir William that if, instead of the State taking over the railways, they were taken over by a public authority, he would be satisfied, although he preferred Government control, so that there would be a discussion in Parliament on the railway budget. To Sir Henry Primrose he said that the analogy of the State purchase of British railways would be more like the Swiss example than the German—there were more companies and their difficulties were more like ours. He admitted that the Act of 1844 granted twenty-five years' purchase, and that the change to twenty would have to be justified. It was not, he considered, fair to adhere to terms fixed seventy years ago, but, on being pressed, he acknowledged that twenty-five years' purchase was the condition generally fixed in such transactions. Witness was then examined somewhat closely by Mr. Jackson as to the financial conditions—the payment of debentures, preference stock, &c.—to which we will refer when the full evidence is available.

Mr. Davies then came under the examination of Mr. Prothero, who pointed out that many of his statements as to the superiority of German, Swiss, and Belgian railways were incompatible with the facts. Mr. Prothero quoted from the report of Messrs. Reyntiens and Pearson on German railways to the Board of Trade Railway Conference, and showed the many grievances under which traders laboured. Then, that in the twelve years 1900–1911 there had been three deficits on the Belgian railways, entirely due, Mr. Prothero believed, to political pressure, and that a Commission was now sitting to see whether the railways could not be taken from under State control because of the political pressure that was brought to bear. Further, that the Belgian Light Railways, although nearly wholly State-owned, were administered by a private company, in order, he maintained, to keep them from political influence. In the French railway strike of 1912 the trouble on the Western—a State line—was more bitter than elsewhere, and the men were disillusioned as to the benefits of nationalisation. But Mr. Prothero's severest criticism was reserved for the results in Switzerland. In the Message as to the State purchase of the Swiss railways the people were told that the administrative staff would be reduced, but Mr. Prothero showed that it had not only increased in number, but in cost. A reduction in tariffs was promised, but in 1912 it was officially stated that the greater part of the hopes expressed in the Message could not be realised, and that tariffs would have to be raised. The lowest tariff was to have been the amount of the highest after the railways were nationalised, but all the tariffs were now higher than before. More frequent trains were promised, but this promise had not been realised. And, as to the staff, Mr. Prothero read an extract from a publication dated July, 1913, which showed that "a tide of indignation prevailed."

Answering the Chairman, Mr. Davies said that working agreements should be encouraged, as they went towards nationalisation, but they should be approved by Parliament, as, being in favour of the companies, they would probably be against the public interest. All the benefits, except workmen's fares and services unprofitable directly, but benefiting the community, that he had recommended could be obtained by unification. Lord Loreburn then went through Mr. Davies's estimates of the cost and savings and showed how easily the latter could be turned into a deficit, to which the witness replied that greater travel and other compensations would overcome this.

The sitting closed with a remark, worthy of consideration, by Lord Loreburn *à propos* of Mr. Davies' opening sentence, that transport was only one of the "services that are essential to every branch of trade and commercial activity." Would the State purchase of essential services end at railways? The Commission then adjourned until yesterday (Thursday) afternoon.

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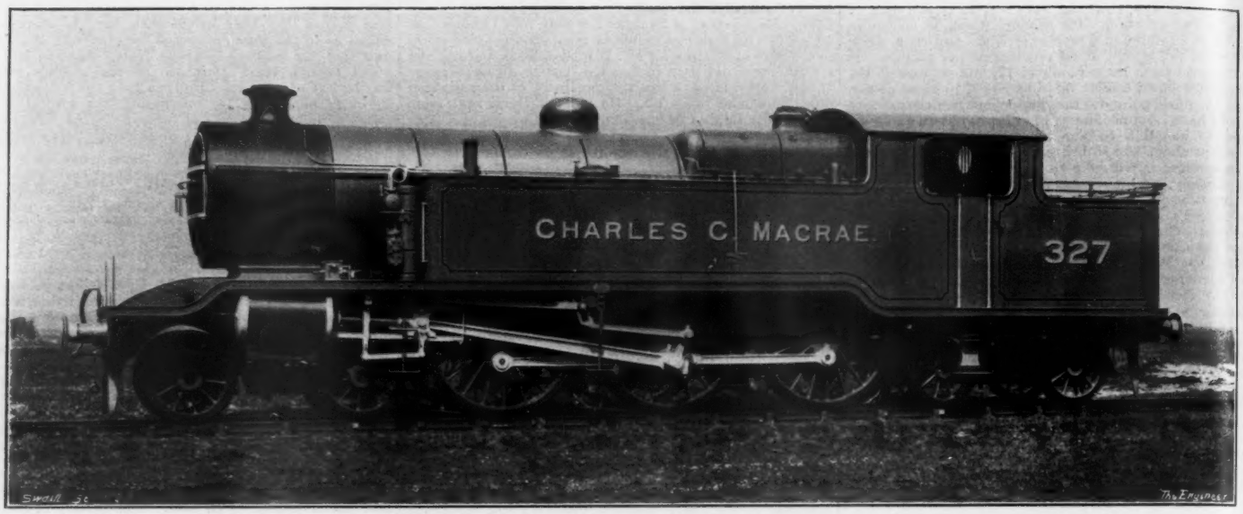
ELECTRIC trains are now running between the High Level Station, Willesden, and Earl's Court, in place of the London and North-Western steam service. The coaches intended for this work not being ready, the service is being given by District Company's stock, worked by North-Western trainmen. The London and North-Western new trains will be in sets of three coaches, with seating accommodation for 38 first-class and 128 third-class passengers

# LONDON, BRIGHTON, AND SOUTH COAST RAILWAY—BALTIC TYPE TANK ENGINE

MR. L. BILLINTON, BRIGHTON, ENGINEER




## L.B. AND S.C.R. "BALTIC" TYPE EXPRESS PASSENGER TANK ENGINE.

THE beginning of the present month witnessed another step in the forward policy of the Brighton Railway Company, when the first of a series of seven "Baltic" express tank locomotives was put into service. These engines, one of which is illustrated above, are being built at the company's workshops at Brighton to the design of Mr. L. Billinton, the locomotive engineer. It will be seen from the illustration and the particulars which follow that the engine is one of great power, and it is no exaggeration to say that it is the largest express tank engine which has ever been built for service in this country. We should like to offer Mr. Billinton our congratulations on its excellent design.

The line from London to Brighton, a distance of 51 miles, abounds in gradients and curves, and the start from either end is on a fairly stiff bank. Leaving Victoria on an up gradient of 1 in 64, the first 18 miles up to Quarry Tunnel is collar-work all the way, the gradients from the 15th to the 18th mileposts varying between 1 in 100 and 1 in 165, the ruling gradient of the line being 1 in 260. The first 11 miles of the road from London is, moreover, very tortuous, and, owing to the network of suburban lines, the crossings are numerous and the traffic congested, so that a free road is seldom obtained before Croydon is reached. The schedule time for the journey to Brighton is sixty minutes, with a train load of 290 tons, but this is easily accomplished by the two experimental tank engines of the "Pacific" type, which have done excellent work on the service during the last two years.

The success of the "Pacific" type has induced Mr. Billinton to take the bold lead of designing this new tank engine of the "Baltic" type of such proportions as to meet the most exacting requirements of the line, and, by providing sufficient coal and water capacity, to enable it to undertake the longest non-stop run on the system, viz., from London to Portsmouth, a distance of 87 miles, the minimum timing being 106 minutes with loads of 280 tons.

If these engines prove as successful as their predecessors of the "Pacific" type—and there seems to be no reason why they should not do even better—it is a foregone conclusion that, in future, powerful tank engines of this class will, in all cases, be used in preference to tender engines, and so reduce the extra dead load of tender weight which has to be hauled at present. The boiler is of ample capacity, with a fire-box of the Belpaire type, and fitted with flue tubes for a Robinson superheater. It will be remembered that the Belpaire fire-box was adopted by the Brighton Company for the first time on its new "Mogul" goods engines, which were turned out at the end of last year, and which have proved to be highly successful. These engines were illustrated by a coloured drawing in our issue of January 30th.

The piston valves, with internal admission, are operated by Walschaerts valve gear. The screw reversing gear, with air-assisting cylinder, is of the standard type used on the Brighton line, and described fully by us in the issue already referred to. The cylinders are fitted with the new type of combined vacuum and water relief valves, which were designed for the "Mogul" engines, and have been found to work satisfactorily. These valves are placed at the bottom on each end of the cylinder barrel. The piston-rod metallic packing is of the non-floating type, enclosed in an air-cooled case, the piston tail-rod being carried in an enclosed sleeve. The cylinders and piston valves are lubricated by means of an eight-feed "Hine" mechanical lubricator.

The wheel base is symmetrical about the driving wheels, and the bogies, which make ample provision for side play when passing round curves of 5 chains radius, are side-controlled by coiled springs and levers. To minimise rolling, side bolsters are also provided on the bogies.

The feed water in the tanks is heated by exhaust steam from the cylinders, and is delivered to the boiler by means of a Weir feed pump fixed on the platform at the front end of the left-hand tank. A Gresham combination injector—hot-water type—is fitted to the back of the fire-box as an auxiliary to the pump.

The engine is fitted with a Hasler speed indicator and recorder, which records the speed on a continuous roll of paper at intervals of three seconds, registering the mean speed during the three previous seconds.

Train heating apparatus and Westinghouse brake fittings of the standard quick-acting type, with large reservoir capacity for heavy service, are also provided.

The following are the leading dimensions and particulars:

| | |
|---|---|
| Cylinders | 22in. dia. × 28in. stroke |
| Piston valves | 10in. dia. × 5¼in. maximum travel |
| Coupled wheels | 6ft. 9in. dia. |
| Bogie wheels | 3ft. 6in. dia. |
| Rigid wheel base | 14ft. 9in. |
| Total wheel base | 40ft. |
| Total length over buffers | 50ft. 4¾in. |
| Working pressure | 170 lb. per sq. in. |
| Heating surface— | |
| 123 tubes 2in. dia., outside | 1082 sq. ft. |
| 21 tubes 5¼in. dia., outside | 453 sq. ft. |
| Fire-box | 152 sq. ft. |
| Total | 1687 sq. ft. |
| Superheater | 383 sq. ft. |
| Grand total | 2070 sq. ft. |
| Grate area | 26.7 sq. ft. |
| Tank capacity— | |
| Water | 2700 gallons |
| Coal | 3½ tons |
| Weight on coup'ed wheels | 56½ tons |
| Maximum weight in working order | 98 tons |

## A NEW SEPARATOR.

THERE has recently been put upon the market by the Diamond Blower Company, Limited, of 75B, Queen Victoria-street, E.C., a new separator, which is said to be highly efficient. It is intended for the treatment of exhaust steam, and may, we are told, also be used with equally satisfactory results in connection with the gas, chemical and sugar industries. It may also be used for compressed air, and, when slightly modified, can deal with steam supplied to turbines. Within the casing—Fig. 1—is a series of baffle plates—Fig. 2—which are placed

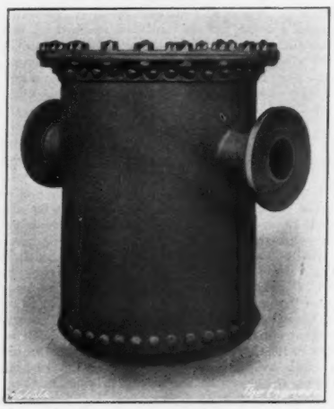


Fig. 1—THE SEPARATOR CASING

vertically. These plates—as Fig. 2 shows—are provided with a number of slots and tongue pieces, inclined at an angle of 45 deg. The extremities of the tongues of one plate butt against the adjacent plate, and are so arranged that the oil or whatever is being dealt with flows along the double bottoms of the plates to the end or bottom of the casing, where it is discharged at will through an outlet port or cock. Steam entering the separator strikes these tongue pieces, and is deflected and made to pass through the gaps. The total space between the tongue pieces in any section of the separator is equal to the area of the exhaust pipe, thus eliminating back pressure. As the gaps in the front row cover the tongue pieces in the second row, the steam is again deflected, and so on all through the plates. Every time steam hits a series of tongue plates, it is robbed of a certain amount of oil and moisture, and by the time it reaches the outlet end of the separator it is thoroughly cleansed and perfectly dry.

The separators can be supplied to fit pipes from 1¼in. diameter to 17in. diameter, or even larger pipes if necessary. Furthermore, they are made to suit horizontal or vertical pipe lines, or to fit in as an elbow piece. Several arrangements are shown in Fig. 3. The makers prefer to mount the separator behind the cylinder of an engine, but this, of course, is not absolutely necessary. In the case of engines exhausting to atmosphere, with a

Fig. 2—BAFFLE PLATES

small back pressure, a syphon pipe is connected in the discharge pipe for the oily water, the length of the syphon—as indicated at *a* on the left of Fig. 3—corresponding to the back pressure. When engines work at a higher pressure than 15 atmosphere, a condensing box K—as shown in the middle of Fig. 3—is provided; its function being to remove the oily water automatically. When the separator is used with condensing engines, a closed collecting box—as shown at B—is used, which is connected with the discharge pipe of the oil separator, the vacuum piping and a steam pressure pipe. In the case of large engines and when large quantities of oily water have to be dealt with,

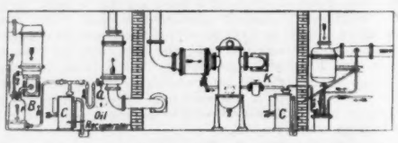



Fig. 3—VARIOUS ARRANGEMENTS OF SEPARATORS

it is advisable to use a pump, especially if the oil filter to which the oil is being forced is at a higher level than the separator. But if the separator is working under vacuum it is not necessary to employ a pump or collecting vessel, for an automatic water conductor is then sufficient.

The separators are fitted with removable covers, which enable the internal parts to be examined with ease, but the makers contend that periodical inspection of the plates is unnecessary, as they are self-draining. The velocity of the steam is sufficient to prevent the molecules of oil or moisture collecting on the tongue pieces. Furthermore, the deflection ridges in the double bottoms, together with the assistance of gravity, have a tendency to force the oily water to the bottom of the casing out of the path of the steam.

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IN a paper recently issued by the United States Bureau of Standards the results are given of an investigation of eight flow-calorimeters, representing types widely used. The investigation has shown that several of the calorimeters could be used, when proper precautions were observed and suitable corrections applied, to determine the total heating values of gases to an accuracy of about 0·3 per cent. Some calorimeters are, however, subject to errors that cannot be eliminated except by comparison with a standard instrument, such errors for one calorimeter amounting to nearly 2 per cent. Examination of a very large amount of data indicates that with these calorimeters, free from significant errors, values should be determinable to an accuracy of the order of 1 per cent.

# CENTRAL EXHAUST STEAM ENGINE

HICK, HARGREAVES AND CO., LIMITED, BOLTON, ENGINEERS

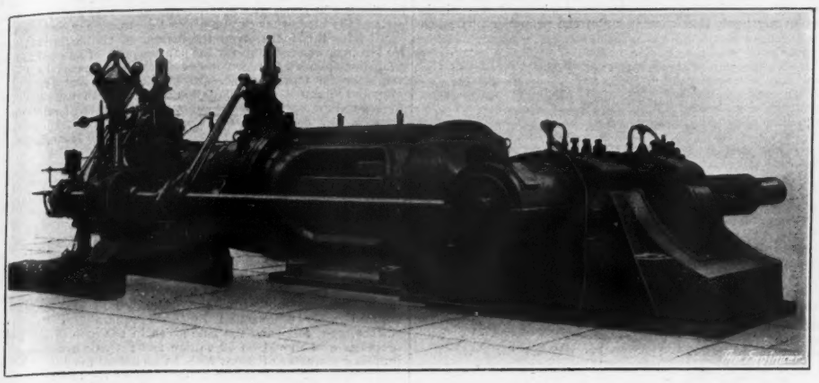


Fig. 1

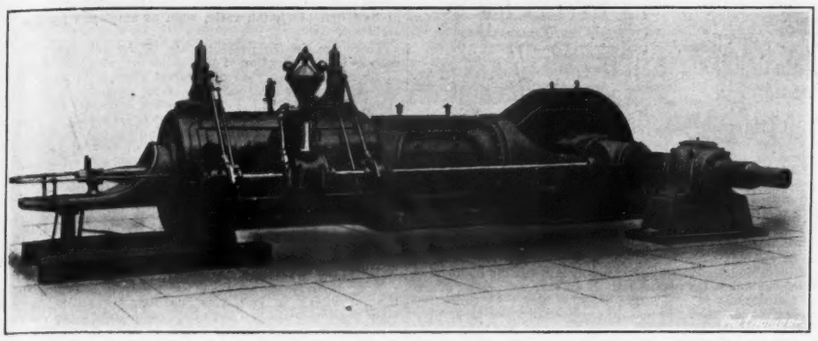


Fig. 2

## A CENTRAL EXHAUST STEAM ENGINE.

URGED on by the competition of the various types of internal combustion engine with their high thermal efficiencies and low fuel consumption, the designers of steam engines have, in recent years, had to bestir themselves to provide improvements whereby the consumption of steam can be brought down to the lowest possible limits. Perhaps the most marked progress has been shown in engines of the "one direction" flow type, in which the heat losses in the cylinder are reduced to a minimum by maintaining the temperature of the cylinder ends more constant than is possible in steam engines of the ordinary kind, and thus preventing condensation. The Stumpf engine is the pioneer in this class, and, as most of our readers are aware, this engine has, in place of the exhaust valves at each end, a series of ports placed midway in the length of the cylinder, the ports being uncovered by the piston at the end of the stroke to allow egress of the steam after it has done its work. The inlet valves are of the ordinary drop or piston type. Although remarkable results have been obtained from engines of this type with only one cylinder and efficient condensation, certain drawbacks have been found. One of these is the seizing of the piston and fracture of the cylinders due to unequal expansion and weakening of the cylinder by the arrangement of the circumferential ports. To overcome this, it is now customary to bore the cylinders with a slight taper. This class of engine also requires a very massive piston—nearly equal to the length of the stroke—and a cylinder about equal to twice the length of the stroke. With these proportions of piston and cylinder the exhaust takes place at about 90 per cent. from the end of the working stroke, and compression begins at about 10 per cent. of the return stroke. It will be seen that the period of exhaust in this type of engine is very short, while the duration of the compression is correspondingly long, so much so that means of increasing the clearance spaces when exhausting to atmosphere have to be provided.

In Tabourin's central exhaust valve engine the good features of the uniflow type have, it is claimed, been retained, while certain modifications with a slight increase in mechanism have been introduced. For instance, the lengths of both the cylinder and piston have been reduced, and it is claimed that the wear of these parts is correspondingly minimised: the points of compression and release are controllable, and the additional clearance spaces are eliminated.

Figs. 1 and 2 herewith are produced from photographs of a steam engine which is being built in this country by Hick, Hargreaves and Co., Limited, Bolton, on these lines. It may be broadly described as a central exhaust engine of the well-known Stumpf type, with a modified

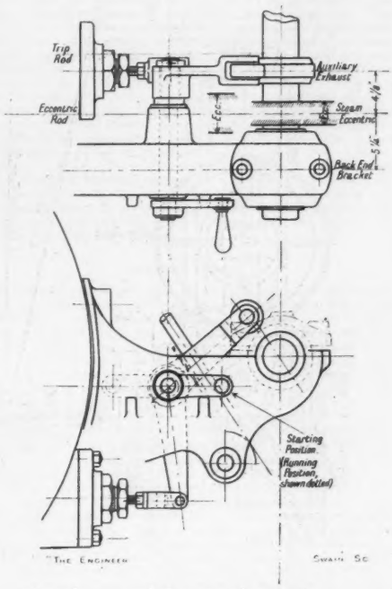



Fig. 4—AUXILIARY VALVE GEAR

cylinder, shorter piston, and the addition of a central exhaust valve—Tabourin's patent. From the detail drawings—Fig. 3—it will be observed that the steam cylinder is of simple form, has no jacket, and is free to expand without introducing distortion troubles. The depth of the piston and length of the cylinder are normal. Steam is admitted to the cylinder by means of double-beat equilibrium or drop piston valves in the end castings, and is exhausted through the ports in one side of the cylinder only, as shown. During the stroke the main piston passes over these ports, but the actual opening to exhaust is controlled by means of the piston valve in partial equilibrium—Figs. 3 and 6—placed at the side of the cylinder and connected with the ports in the wall by a passage, care being taken that the clearance space is not increased. This arrangement permits of the use of a piston of the usual depth with a corresponding reduction in weight, and the minimum wear of the lower side of the

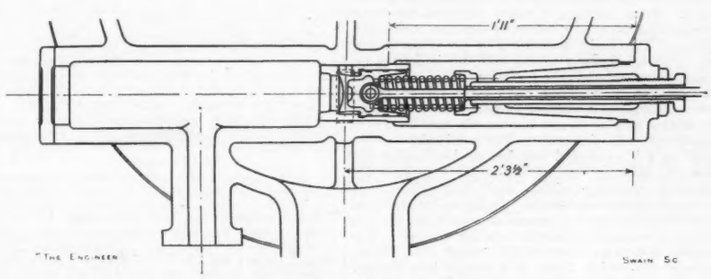



Fig. 5—AUXILIARY EXHAUST VALVE

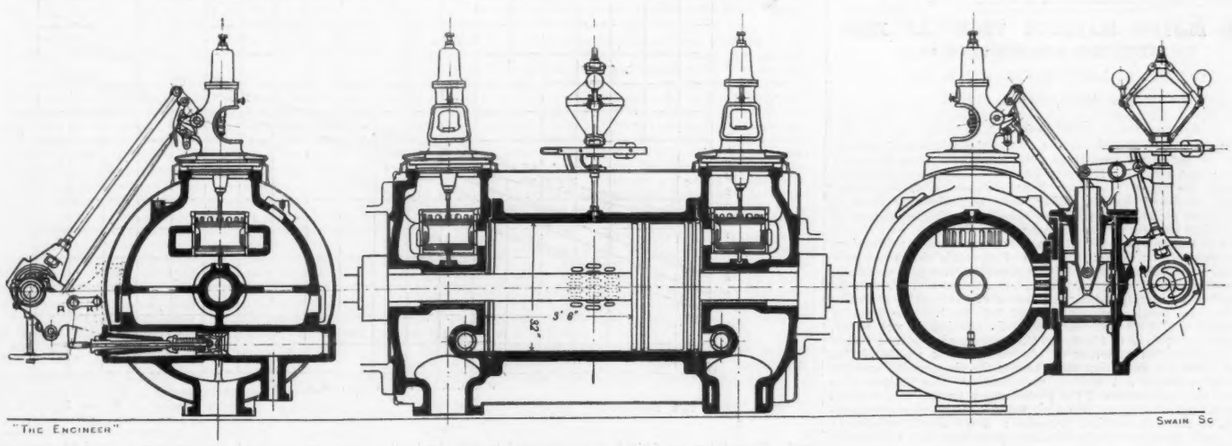



Fig. 3—SECTIONS OF CENTRAL EXHAUST ENGINE CYLINDER

cylinder. Below the cylinder and in the positions usually occupied by the relief valves will be noticed auxiliary valves—Figs. 4 and 5—which serve a threefold purpose. They are operated by means of a cam on the lay shaft and can be put into action at will, as shown, thus prolonging the period of exhaust after the main piston has closed the central exhaust ports, and permit a compression as low as from 8 to 10 per cent. if desired. Further advantages

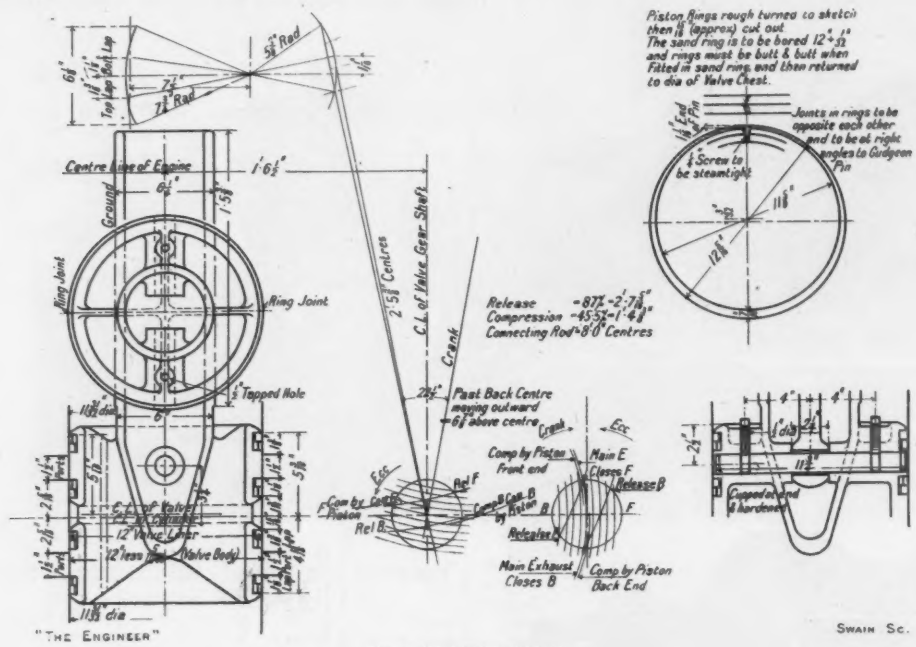

Piston Rings rough turned to sketch then 1/16 (approx) cut out
The sand ring is to be bored 12" .1"
and rings must be built & built when
Fitted in sand ring, and then returned
to dia of Valve Chest.
Joints in rings to be opposite each other and to be at right angles to Gudgeon Pin
Screw to be steamtight
Centre line of Engine
Ground
Ring Joint
Ring Joint
½" Tapped Hole
C.L. of Valve Gear Shaft
Crank
Release -87½-2'7⅞"
Compression -45·5X=1'4⅜"
Connecting Rod=8'0" Centres
Past Back Centre moving outward =6⅛ above centre
Comp by Piston Front end
Main E Closes F
Release B
Main Exhaust Closes B
Comp by Piston Back End
Cupped and hardened
"THE ENGINEER"
SWAIN Sc.

Fig. 6—EXHAUST VALVE

fully to meet the requirements of the aeronautical designer. According to this theory, the propeller blade is treated as an aerofoil, its $P/V^2$ ratio at every point of the blade is fixed by the same law as that of the aerofoil as given; following this, the gliding angle of the propeller blade is constant from root to tip. The section of the blade is at every point designed as an aerofoil in which the true helical surface corresponds to the horizontal plane in flight. Under these circumstances, it is shown in my work that each point of the propeller blade has

claimed for these valves are their utility for scavenging the cylinder of dirty oil and their freedom to operate as relief valves independent of the cam motion. The admission valves are operated by variable trip gear and excentrics from a lay shaft driven by bevel gearing from the extension of the crank shaft, the opening of the valves being controlled by means of a governor of the usual type. The exhaust valve is of the piston class, working in a cast iron liner, and is operated from the lay shaft by means of an excentric and rocking lever, as shown. The stroke and lap of this valve are fixed and unvariable.

In case the engine is required to run non-condensing it is only necessary to throw over the hand levers, which put into action the cams operating the special valves at each end of the cylinder. A feature of this engine is the ease with which it can be opened out to examine the piston and cylinder. After undoing a seam of bolts the back cylinder cover can be easily removed by the racks and pinions shown. The main bearing is in three parts and adjustable. The lubrication of the cylinder is forced by means of a mechanical sight-feed device. The main and outer end crank shaft bearings have large oil boxes on the pedestal caps supplied with oil by two valveless pumps driven by chain gearing from the crnak shaft. These pumps supply oil under pressure to the crank pin.

An engine of this type and capable of developing 800 horse-power has been in use driving a paper factory for several months, running night and day without a stoppage, except at the week-ends. It has cylinders 32in. diameter by 3ft. 6in. stroke, steam pressure 125 lb. per square inch, and runs at 120 revolutions per minute. The engine is fitted with a governor of the "bent arm" type, in connection with which there is a safety trip device. This serves to cut off the steam supply should the driving gear of the governor fail, when the steam valve would be opened to the full extent; or it cuts off the steam in case of overspeed when the governor balls have reached their highest position.

## THE FLYING MACHINE FROM AN ENGINEERING STANDPOINT.*

By F. W. LANCHESTER, M. Inst. C.E.

(*Concluded from page 517.*)

### Propulsion.

We are now in a position to consider the question of propulsion. Whether we appeal to experience or theory it would appear that there is only one method of propulsion available, namely, the screw propeller. Nature's method of propulsion—wing flapping—besides being very objectionable from a mechanical point of view, shows certainly no higher degree of mechanical efficiency than the screw propeller.

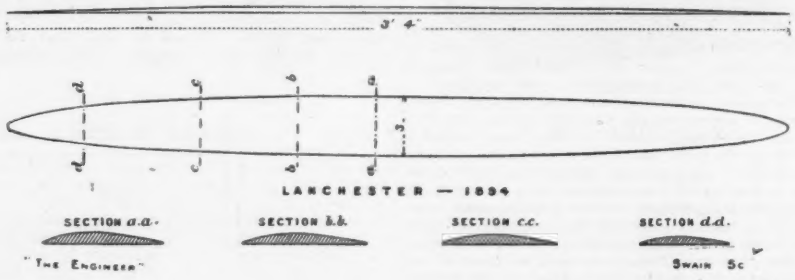
The problem of propulsion, whether aeronautical or submarine, is essentially the same; the laws of dynamic similarity with certain reservations are strictly applicable. Roughly speaking, the conditions of usage of propellers in water and air may be compared by merely taking cognisance of the relative densities of the two media—approximately, 800 to 1. The laws of dynamic similarity indicate that this relation is not exact, but any refinement of theory on this score is of academic rather than of practical importance. Apart from fine points of this kind, there is a limitation that renders the air propeller and the marine propeller not strictly comparable; this limitation is due to the appearance of the phenomenon known to the naval engineer as cavitation. No such thing as cavitation is experienced in the aeronautical propeller; if we should require to deal with propeller blade speeds approaching the velocity of sound, we might find something analogous, due to the high rarefaction of air, but at present the aeronautical designer can afford to ignore all question of cavitation.

It is frequently stated that the theory of the screw propeller is entirely empirical and quite unsatisfactory; this is not my opinion. The theory of the screw propeller based on the theory of the aerofoil as laid down in my "Aerodynamics," appears

* Institution of Civil Engineers. James Forrest Lecture.—Abstract.

efficiency proper to itself. Unfortunately, we cannot use only the region of maximum efficiency; we have to employ the blade of considerable length, and consequently parts of the blade have an efficiency below the maximum. If we take a propeller of the usual proportions in which the pitch is about 1½ times the diameter, we see that the marine engineer declines to employ any portion of the blade with an efficiency of less than about 92 per cent. of the maximum, that is to say, the efficiency of

Fig. 8.




different points of the blade varies from 77.5 to 81 per cent., or theoretically the limit of efficiency of such a propeller should be round about 77 per cent. Unfortunately, a propeller "in being" cannot consist of blades alone; it requires a boss and a connection between the boss and the blades, and in driving these functionally useless parts through the water, a considerable further loss is inevitable. Probably, it is for this reason that the actual efficiency of a marine propeller rarely exceeds 70 per cent. Everything considered, I am disposed to put the limit of efficiency of an aeronautical propeller at about 85 per cent.; this is higher than has been found possible in marine engineering.

There should be nothing to prevent the marine propeller—at speeds below the cavitation point—giving as high an efficiency as the aeronautical propeller, were it not for the limit imposed by the strength of materials. To obtain the highest efficiency, even in an air propeller, it may be found necessary to abandon the wooden blade and substitute a solid nickel steel blade of somewhat the sectional form given in Fig. 8. This, in the case of an 8ft. propeller, would mean a blade 4ft. long, the outer 3ft. of which would be the effective blade, the maximum width in the widest part being no more than 3in. or 4in. If any attempt were made to design such a propeller for marine work, there is no material known at the present time that would stand the stress involved; the pressure reaction, speed for speed, would be about 800 times greater in water than air, and the aspect ratio of the blade that can be utilised for marine work is strictly limited by this fact; even the softest of timber is relatively far stronger as a medium for the construction of an aeronautical propeller than any known material, even tempered tool steel, would be for marine work. In the design of an aeronautical propeller advantage may be taken of the fact that a very slight forward slope of the blades relieves the blades of all bending stresses, the resultant of the centrifugal force and pressure reaction is in the line of the blade, and the latter is consequently stressed in pure tension.

There is a practical rule which appears to be commonly adhered to in the design of successful marine propellers for moderate speed sea-going craft. The area of the propeller disc is approximately 1 per cent. of the total wetted surface. This rule has been found by me to represent a rough average of the practice in various cases, but whether it is an accepted rule or not, I do not know. Let us take the case of a flying machine, involving, say, a thrust of 200 lb. at 80ft. per second; at this speed the frictional air resistance will be approximately 0.035 lb. per square foot of surface—0.07 lb. per square foot of lamina, i.e., double surface—thus, the resistance of the machine is approximately represented by 6000 square feet "wetted" surface, and, following the rule given in the case of water, the propeller disc should be 60 square feet; this corresponds to a propeller diameter of about 9ft. In an actual machine of about this size, the propeller is commonly of about 7ft. to 8ft. diameter, which, taking everything into account, is in substantial agreement. The propeller employed in flight is of necessity—from considerations of the engine revolution speed—of finer pitch than that of best efficiency. Under these conditions, theory shows that the correct diameter is less than that of the propeller of best diameter/pitch ratio, such as employed by the naval architect.

There are, in the present state of the art, two prominent reasons for the adoption of a propeller for aeronautical machines of finer pitch than that of greatest efficiency; first, there is the question of suiting the pitch of the propeller to the running speed of the engine. For the power necessary in a modern aeroplane—from 50 to 100 horse-power—a stroke of about 5in. is found to design well in proportioning the engine; now it is uneconomical both from the point of view of weight-saving and of petrol consumption to employ too low a piston speed; in fact, for any given dimensions of cylinder the power developed is within limits roughly proportional to the piston speed. Taking a piston speed of 1000ft. per minute and 5in. stroke, we require 1200 revolutions per minute = 20 revolutions per second. Assuming a velocity of flight of about 80ft. per second, the effective pitch of the screw requires to be 4ft., or approximately equal to half the diameter of the screw, instead of at least equal to the diameter, as in a good marine propeller.

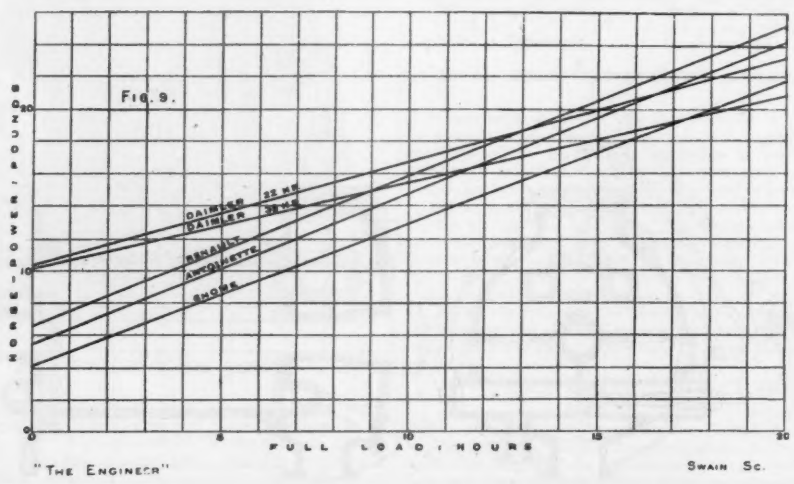
It is, of course, not difficult to gear down from the engine to the propeller; in fact, this has been frequently done, but, since gearing involves a tax of approximately 5 per cent. of the horse-power, it is evidently better to drive direct and sacrifice something in the efficiency of the propeller, more especially as this course involves a far lower torque on the propeller shaft, and consequently a lower recoil torque on the framework of the machine.

### Motive Power Installation.

We are now faced with the consideration of the motive power installation. At the present time the petrol motor holds the field. No other prime mover is able to compete either on the score of weight per horse-power or fuel weight economy; there is nothing in sight likely to oust the internal combustion motor from its supreme position.

The relative importance of lightness and economy of fuel is determined by the class of service for which the motor is required. In Fig. 9 curves are given of weight/horse-power for various motors; ordinates represent weight of motor plus fuel, abscissæ the duration of the run at full load. It can be seen at a glance from this diagram that for brief periods the weight per horse-

Fig. 9.



power of the engine is the all-important factor, whereas for long runs this becomes relatively less important, the weight of petrol and lubricating oil becoming the main item. It will be noted, taking the extremes, that the Gnome engine starts with a very considerable advance over the motor car engine given for comparison, but after a run of 17 hours at full load, the motor car engine—represented for the purpose of illustration by the Daimler—by its greater economy has taken the lead. Many of the aeronautical motors of the present day combine with a weight/horse-power factor of about 4 a degree of economy that compares well with the best automobile practice.

Out of a great multiplicity of types of aeronautical engine now on the market there are two types, namely, the rotating engine on the one hand and the light-weight multi-cylinder Vee type on the other, which I consider likely to survive. The rotating type of engine gives the possibility of very complete balance with simplicity of working parts, and so provides the aeronautical constructor with an engine especially serviceable where small machines are concerned, and simplicity and upkeep are of importance. The rotating engine is at the present day reasonably economical in petrol, but is grossly extravagant in lubricating oil, and, consequently, is at a disadvantage for long-distance work; it will, however, probably hold its own for some time to come in machines for short-distance flying. The rotating engine also suffers from some disadvantages on the score of exhaust silencing. The multi-cylinder Vee type, though ordinarily not so light, power for power, as the rotating engine, has many advantages, especially for high power and where long distances have to be negotiated.

It is customary in the rotating engine to employ direct air cooling; it is, in fact, difficult to arrange such an engine with water cooling. The horse-power absorbed in the Gnome engine incidental to air cooling is very great; in the original so-called 50 horse-power Gnome—which actually gives very little over 40 horse-power in flight—the power consumed in wind resistance, even on the test stand, amounts to nearly 6 horse-power, and it may be materially greater under flying conditions.

In engines of the Vee type water cooling is in greater favour; the Renault special aeronautical motor is an exception, being cooled by air blast generated by a centrifugal fan. The weight of the water cooling system when fitted amounts at the best to 0.6 lb. per horse-power—with water nearly 1 lb. per horse-power and thus constitutes a serious addition to the weight of the installation. Here, again, the class of service becomes important. It is evident that for short-distance flying, where engine weight is of paramount importance, it may be better to employ direct air cooling; when, however, a long-distance service is required, it may arise that the weight of the water cooling system is justified by the saving in horse-power and better fuel consumption.

We may now proceed to consider the inter-relation and compatibility of engine and propeller. It has already been pointed out that in order to get the full output from a given engine—as is also well known to be the case in marine propulsion—a propeller pitch has often to be selected far from that proper to highest efficiency. The difficulty has, as in the early Wright machine, been met by adopting a reduction gear; alternatively—as also in the Wright machine—a multiplicity of propellers may be employed. It is evident, for example, that if four propellers be used in place of one propeller, the individual diameter may be halved, and, consequently, for a given pitch—and therefore revolution speed—the pitch diameter ratio doubled. The original Wright machine furnished a good example of a case in which the propeller pitch/diameter ratio was made approximately that of best efficiency, and this result was obtained in spite of the low velocity of the Wright machine, by a combination of both methods—that is to say, two propellers were used instead of one, and these propellers were geared down from the engine in the relation 10 to 33.

The incompatibility at present existing between the engine speed and the propeller pitch becomes less as the flight velocity is increased, so that, in the case of an ordinary machine of about 1400 lb. total weight, the propeller speed, for best efficiency, for a single-screw machine becomes appropriate to the normal engine speed at about 100 miles per hour. Since the loss of efficiency for a fine pitch propeller, even down to half the pitch ratio of best efficiency, is not great, it may be taken that for flight speeds of 50 miles an hour upwards the balance of advantage lies definitely with the direct-coupled propeller. This agrees with experience. A point of interest in connection with propellers of comparatively fine pitch and somewhat reduced diameter, such as commonly in use to-day, is the fact that with the engine opened fully out, there is very little difference between the thrust and the revolution speed whether the machine is standing or is in full flight—it is commonly reported that the revolution speed does not increase more than 10 per cent. from "standing" to full normal flight speed—the thrust variation also is slight. This fact constitutes the only justification for the static test of aeronautical propellers, frequently resorted to when approximate data are required. There is no doubt that in a propeller of theoretically perfect proportion, or in an existing propeller if fitted to a machine of less resistance, there would be a far greater response to flight speed variations. Actually this is the case in marine propulsion where the propeller revolution recorder is commonly found to give more reliable readings than the ship's log.

## Relating to the Design of the Aerofoil.

We shall now proceed to the discussion of the more detailed arrangements and structural features of the machine. First, the aerofoil. The pressure appropriate to least resistance is given by the expression $0.32\ \rho\ V^2$ in abs. units, or $\rho\ V^2/100$ in lb. per square foot. Consequently if $w$ is the weight in flying order, the area required is $100\ w/\rho\ V^2$ as appropriate to least resistance.

The above is the whole basis of any initial "lay-out." There are many refinements, however, to be considered which enter into the complete problem. The principal of these are:—The fact that part of $w$ is a function of the aerofoil area—the quantity we are determining—means that the best area will be less than given by the foregoing expression.

Beyond the above specification of flight velocity for any machine consists more often than not in the prescription of higher and lower limits rather than of a set fixed speed.

Briefly, for a given machine the extent of the flight speed variation is a function of the reserve of thrust over the minimum resistance value, the absolute value of the limits being fixed by the load that the aerofoil is called upon to sustain. In the case of a high-powered machine, however, the lower limit may be prescribed by the critical angle of the aerofoil.

The choice between monoplane and biplane is, in the main, a question of constructional engineering; there is not a great deal to choose between the two from an aerodynamic standpoint, but with equally good design the monoplane gives a slightly better lift/drift ratio.

Considering the aerofoil, whether monoplane or biplane, from a structural standpoint, and in investigating the strength of the aerofoil as a whole, it may be treated definitely as an inverted cantilever system. Thus, comparing the stresses in an aeroplane to the stresses in a cantilever bridge, we have the weight of the fusillage with its alighting chassis, motor, passengers, &c., the inverted equivalent of the supporting reaction on the central pier of a cantilever girder. We have the air pressure force, by which the load is sustained, distributed along the aerofoil length corresponding to the weights of the outstanding members of the cantilever. We have a variation of pressure from point to point due to gusts, eddies, &c., corresponding to some degree to the movable loads representing traffic over the bridge. In the case of the aerofoil, we have in addition something not represented in the analogy of the cantilever girder, *i.e.*, the weight of the aerofoil itself directly supported by the pressure reaction; we may, however, regard this equal and opposite distribution of weight and pressure as superposed on the main system, and as not contributing to the stresses in the aerofoil members. So far as the analogy to the bridge holds good, it is evident we have a well-known engineering problem which is capable of being treated by well-known methods. In the calculation of stresses of the aerofoil members two alternative methods are in current use; in the one the aerofoil struts are treated as pin-jointed members by the usual truss girder construction; according to the other method, in place of the hypothesis of the pin joint, we have the hypothesis of continuity in the main longitudinals. The first and simpler method has been used by several firms for many years past, and gives results which, under ordinary conditions, are very much on the safe side; the second method has been developed during the last few years by the National Physical Laboratory, and has been adopted by the Royal Aircraft Factory, and more recently by other manufacturers.

On the pin joint hypothesis the stresses are solved by the well-known graphic stress diagram. The alternative method is considerably more complex. Reference should be made to the report cited. It is well to remark that, though the pin joint hypothesis gives results usually on the safe side, the extent of the factor of safety so introduced is not one that can be relied upon, and may in special cases be even negative. It is hardly necessary to point out that the more important and vital the problem the less appropriate become methods of an approximate and inexact character.

## The Dynamic Load Factor and Factor of Safety.

A matter of importance, and one of a controversial nature, is the factor of safety necessary in order to take care of the many and varied conditions met with by a machine in flight. In the simple case of a machine in horizontal flight in calm weather we know that the load supported by the aerofoil is the weight of the body of the machine and its associated parts, but not including the aerofoil itself, whose weight is directly distributed over the pressure surface; also we know that in the various evolutions a machine is called upon to perform the stresses may considerably exceed the normal, and that variations of effective load are experienced due to wind gusts which it is quite out of the power of the pilot to prevent. Excluding for the time being the latter, we are clearly able to define the worst that the pilot is able to do and specify the factor by which the normal stresses must be multiplied in order to represent the actual stresses; conversely, we may specify arbitrarily a factor of safety, and we may tell the pilot just what he is permitted to do, and just what he cannot undertake without risk. Taking in the first instance the assumption that the pilot is allowed to do his worst, he is to be allowed *to try to wreck his machine*. There are two ways in which he can operate; first, he can drive his machine at the highest possible speed and suddenly alter his elevator to the position corresponding to the lowest possible speed; alternatively, he may take sharp turns involving heavy banking. Now, the highest possible speed is the limiting velocity which the machine will acquire falling head first vertically; this, with machines at the present day constructed, may be estimated at about 140 to 150 miles an hour. The lowest velocity in the present sense is the velocity at which the aerofoil is meeting the air at its critical angle—the lowest velocity capable of giving a pressure reaction equal to the weight; this may be taken for the purpose of our argument as 40 miles an hour. If when falling vertically at 140 miles an hour the pilot with absolute suddenness jerks his elevator into the position corresponding to 40 miles an hour, the reaction brought to bear on his aerofoil is $\left(\frac{140}{40}\right)^2$ W, that is to say, approximately twelve times the weight of the machine. In practice, for the figures given the maximum load would be diminished, since the elevator cannot be moved with absolute suddenness, and, if it were, the machine could not answer the elevator and alter its attitude to the line of flight immediately. It is probable on the basis of the figures given that 10 W is the maximum effective load that could under any circumstances be brought to bear.

In the case of severe banking, if the machine be banked to an angle $\theta$ the resultant of the weight and centrifugal force is the value W sec $\theta$. I have frequently made estimates of the angle of banking when a pilot has been making a steep spiral dive; the angle rarely exceeds 60 deg. or 70 deg. Taking 70 deg. as the maximum, the stresses in the machine will correspond to a load equal to 3 W.

From the foregoing it would appear almost certain that in calm weather the pilot, if asked to do his worst, cannot in any manner reach or exceed ten times the stresses due to the static load.

Let us take what may be considered an extreme gust. The machine enters air, or is struck by a gust represented by a change of velocity equal to half the flight speed. Assuming the machine has time to swing to its appropriate relative direction under the new conditions, a simple resolution of velocity shows that the worst condition is that in which the direction of motion of the gust is directly opposed to that of flight; in such a case the relative velocity of the machine becomes $1\frac{1}{2}$ times normal, and the effective load on the aerofoil will be $(1\frac{1}{2}^2) = 2\frac{1}{4}$ times normal. In case of the machine being struck by a sudden gust or squall, the load will be considerably higher, but still does not approach the figure 10 obtained on the basis of the pilot suddenly "flattening out" when at maximum speed.

It is evident from the foregoing that a flying machine in the course of its normal usage is liable to stresses many times greater than that of its normal load, and the frequency of these stresses, and the total number of times they occur in the life of the machine, will be related to their magnitude by some empirical law for any given class of service. In such a case it is evident that the term "factor of safety" does not carry its ordinary meaning; if, for example, in the lifetime of a fleet of 100 machines the stresses reach six times normal once and five times normal, say, ten times, and four times normal, say, 150 times, it will be certainly sufficient and proper if the designer work to six times the normal load for his elastic limit without using any factor of safety in the accepted sense at all; to do otherwise would be to burden the whole 100 machines with a weight of superfluous material without justification. Whether under these conditions we continue to employ the term "factor of safety" or not, the aeronautical designer must bear clearly in mind that in his particular case his factor has a double function, namely, both to give the margin of strength and durability needed under ordinary conditions of flight and to provide for abnormal conditions of stress, occasionally even almost to the theoretical limit of the strength of the structure.

In Memorandum No. 96 of the Advisory Committee—not yet included in an annual report—the matter is fully considered, and the extreme probable values are estimated as follows:—

| Nature of contingency. | Computed dynamic load factor. |
|---|---|
| Gusts | 4.0 |
| Banking | 1.4 |
| Flattening out | 8.0 |
| Looping | 4 to 5 |

In the report in question the recommendation is made that a factor N be adopted in design not less than 5 or 6, this being considered sufficient to take care of anything likely to happen to a machine with reasonable and proper pilotage. Tests and calculations of the wing spars of different existing machines gave the following results.

| Type. | Value of N. | How determined. |
|---|---|---|
| A | 4 | By experiment |
| B | 4 | " |
| C | 5 | By calculation |
| D | 3 | " |
| E | 3 | " |
| F | 4 | By experiment |
| G | 7 | By calculation |

The Royal Aircraft Factory has adopted a factor somewhat greater than that recommended in the memorandum in question; a machine—G in the above table—of which the aerofoil was tested to destruction, actually recorded 8.4.

In connection with the subject of aerofoil structure it is to be observed that the stress distribution varies considerably under different conditions, namely, at different angles of attack. The aerofoil structure commonly includes two longitudinal members, front and rear respectively, and the proportions of the load borne by each depends upon the position of the centre of pressure and varies with its displacement, which can only be ascertained from experiments on a scale model of the aerofoil itself. This fact needs consideration when computing the maximum stresses on the members in question and the aerofoil structure as a whole.

The calculation of the aerofoil structure not only comprises the resolution of the main lifting force distribution, but also entails the calculation of the longitudinal stresses due to line-of-flight, or "drift" forces. These may be quite moderate under normal flight conditions, but may become far more severe at abnormally high speeds. The treatment of this problem does not offer any serious difficulty; it is to-day generally considered the best practice to provide for the edgewise strength of the wing by its own internal diagonal bracing.

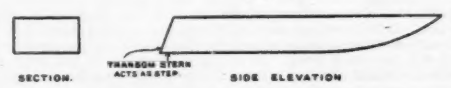
## Landing Gear.

The question of alighting mechanism detail next claims our attention; this is necessarily of two distinct types, depending upon whether the machine is designed for land or for marine usage. Taking first the land or military type of machine, the essential features comprise ordinarily a pair of pneumatic-shod wheels—in some cases two pairs—arranged on a common axis somewhat forward of the centre of gravity of the machine, and supplied with a rudimentary elastic suspension of some form, in addition to runners or skids to take the "bump" in emergency, and the provision of some kind of temporary tail support, consisting either of a castor-pivoted wheel or, as more generally the case, of a simple spring-controlled skid. It was at one time believed to be essential that the alighting wheels should be all castor-pivoted or orientable, the intention being to take care of the relative motion of the ground when alighting across the wind; experience appears to show that with reasonably careful handling this provision is unnecessary. The medium commonly employed to absorb the shock is rubber; this is preferable to steel, as universally employed on road vehicles, for two reasons—first, the energy good vulcanised rubber will absorb is far greater than is the case for steel; it runs to some 500 lb. to 1000 lb. per pound (some 10 or 20 foot-pounds is all that may be allowed for steel); and, secondly, the signs of fatigue in rubber are evident to the most casual observer and the rubbers are cheap and easy of replacement. The alighting wheels with their associated parts are mounted on a structure commonly known as the landing chassis, whose function is to raise the machine proper a sufficient height above the ground to provide clearance for the propeller, aerofoil, &c. Unless careful design and workmanship is put into the landing chassis its "spidery" proportions necessary to give clearance may, on the one hand, constitute a source of weakness, or, on the other, give rise to excessive resistance. Owing to the liability of the landing chassis to injury, it is clearly desirable that its structure should be complete within itself, yet this is very difficult of achievement in actual design; more often than not there are members in common to the landing chassis and the aerofoil structure or the fusillage. This must be considered a weak point in any design, since it involves the risk that some essential flight organ may on landing be strained or otherwise injured or at least stressed beyond the limit for which it has been designed.

In spite of all that has been done up to the present, the landing chassis is only able to take a very moderate "bump" with safety. A 1ft. free fall on to a hard surface is as much as can be deemed safe in the best of existing machines, a free fall of 4ft. or 5ft. would lead to almost certain failure. This requires that in landing a machine should never under any circumstances be allowed to take the ground with a greater vertical velocity component than 8ft. per second. Assuming a gliding angle of $\frac{1}{7}$, this means that a machine flying at 38 miles per hour (56ft. per second) could be allowed to take the ground, presuming the latter horizontal, without intervention of the pilot, but for any higher velocity of flight its course must be eased or flattened: in actual practice it is, of course, part of the art of flying to avoid all shock when alighting, and no pilot would think of taking the ground without at least making his best effort to flatten his angle of descent. There is probably a future for some form of hydraulic pneumatic device; already several attempts have been made in that direction.

Passing now to the marine type, we find in the earlier examples a landing chassis of the ordinary pattern fitted with a pair of

FIG. 10




EARLY TYPE (SMOOTH WATER) FLOAT.

floats in place of wheels and skid, and a temporary tail support in the form of a third float arranged aft under the tail member. In the earlier machines these floats were little more than boxes of rectangular section—Fig. 10; more recently there has been a tendency to give to the floats a more boat-like form, surfaces of single or double curvature being adopted in place of flat, and so the liability to being stove in has been reduced to a minimum. The double-float support has proved itself suited to comparatively smooth water, but a strong feeling exists at the present time that for machines intended to serve on the high seas that construction will be abandoned in favour of the single central boat, as already to be seen in the Curtis and Sopwith machines—Fig. 11. Here auxiliary floats or bob-floats are fitted to the extremities of the aerofoil to give stability to the machine when resting on the water, and to avoid damage to the aerofoil when getting under way or when alighting.

The main floats, whether single or double, require to be constructed to rise in the water on the same principle as the so-called hydroplanes or skimmer craft, being designed with the usual stepped bottom; a single step is found to give the best results.

The design of floats or hull for a marine machine must be regarded as still in an early stage of development, and much will depend in the future on the general evolution of the machine as to what form of float gear will ultimately be found most appropriate. The author is of opinion that as a development of the single boat type at present existing, it would appear to be desirable to bring the motor, or motors, and other heavy parts as far as possible, down into the hull, and design the boat as a thoroughly seaworthy craft with proper metacentric height and fitted with its own (marine) screw propeller, so that it is capable of being navigated independently of its flight organs—Fig. 12. In such a design it would evidently be necessary to drive the propellers through a belt, chain, or gear of some kind, and mechanism would be provided by which the pilot could jettison the super-

structure in emergency. Such a machine would be essentially one of considerable size, and would probably be fitted with two, three, or even more engines, with a total of over 500 horse-power. The weight of such a machine would require to be some 3 or 4 tons, and it would be capable of making port under its own power in the event of the flight organs being abandoned.

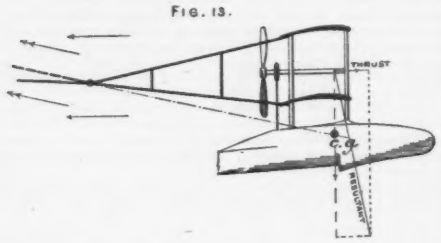
### Acentric Types of Machine.

The type of machine here suggested would be liable to certain objections on the ground that the line of the propeller thrust is acentric, being situated considerably above the centre of gravity, and probably also above the centre of resistance of the machine, conversely the centre of gravity would be considerably below the centre of resistance. These are objections which have been raised with regard to some existing machines. It is undoubtedly desirable, where other considerations permit, to bring the centre of propulsion, centre of resistance, and centre of gravity to approximately the same level. There is no fundamental difficulty in flying a machine in which this condition is not complied with, since any pitching moment that results from the want of concentricity can be corrected by suitably arranging the centre of gravity. Serious difficulty, however, is liable to arise in the event of a sudden change in the mode of flight such as is brought about when the engine is cut out. Under these conditions the machine being propelled in gliding flight by a component of gravity instead of by the propeller thrust, a change of pitching moment takes place equivalent to the total resistance of the machine multiplied by the vertical distance between the line of propulsion and the centre of gravity. In a machine of the type above suggested such a change of moment would be the equivalent of a movement of the centre of gravity through a distance of nearly 2ft., a change which we must regard as of dangerous magnitude.

The position is that shown diagrammatically in Fig. 13, in which it will be seen that the resultant of gravity and the propeller thrust passes some considerable distance in front of the centre of gravity, whereas in gliding flight the resultant of the lifting and propelling forces is the force of gravity, and so passes through the centre of gravity.

It has been suggested that by arranging the tail plane and elevator in the wake, in the propeller slip stream, in fact, and giving it an upward rake—in other words, by employing a negatively loaded tail, the tail may be made to supply a counter-vailing pitching moment when the propeller is at work, thus

Fig. 13.




whilst the direct effect of the propeller is to tend to lift the tail and depress the nose of the machine, the indirect effect brought about by the action of the slip stream on the upturned tail will be the inverse. It might be possible in this way to correct a small want of concentricity of the propeller axis, but such a method would scarcely be applicable to the case in point. In order that the method in question should be effective, the slip stream must be discharged radially from the centre of gravity of the machine—that is to say, the general body of air discharged in the slip stream must be so deflected that its moment of momentum about the centre of gravity is zero. Roughly speaking, this means that the tail, as shown dotted in Fig. 13, must be set at such an angle as, if produced, would pass through the centre of gravity of the machine. The double-headed arrows show the slip stream diverted as theory requires. The method is evidently impracticable; not only is the tail angle as necessitated altogether excessive, but also the whole story has not been told—the tail would require to be "feathered" immediately the propeller ceases its function, otherwise it would continue to supply a moment of some magnitude when no longer required.

### Stability and Control.

In the present lecture all questions of stability in the ordinary sense have been taken for granted. The problems of longitudinal stability, lateral and directional stability, and spiral or rotative stability, though of vital import to the aeronautical engineer, are primarily matters for the physicist and mathematician, and the engineer can well afford to leave questions of this character in the hands of the specialist.

There is perhaps less excuse for the absence of all mention of controlling mechanism. A great deal might be added on that subject without going beyond the scope of the title. However, since the question of control is closely wrapped up with considerations relating to stability, and since it is necessary to draw a line at some point, the omission is one of expediency rather than logic.

The question of stability is not, as is frequently supposed, one that is in any sense obscure; in fact, from the scientific point of view the present position is at least satisfactory. It can be said without exaggeration that we have a great deal more knowledge on the subject than we are at present able to utilise.

In general the work has in the past been treated on too closely mathematical lines to be of immediate service to the engineer. In many cases the writers have clearly suffered from their want of appreciation of the real conditions. It is my deliberate opinion that there is very little room for useful work to-day on the subject of stability unless it be rigidly and directly supported by experimental work, and from our standpoint as engineers I think we may in the future confidently look to the excellent work being accomplished at the National Physical Laboratory, and at the Royal Aircraft Factory, to keep us in touch with that which is essential in this important branch of the subject.

Fig. 11.

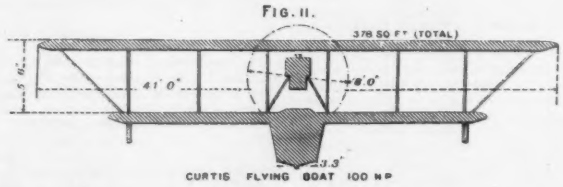
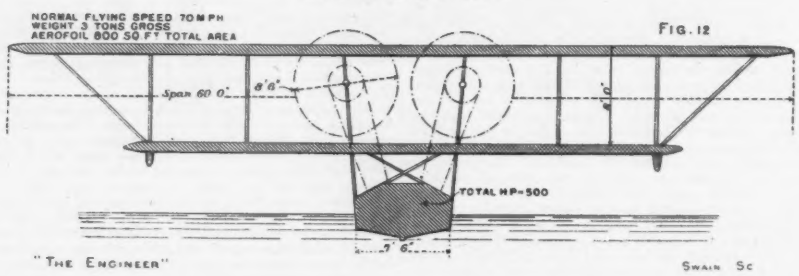



Fig. 12




## LAUNCHES AND TRIAL TRIPS.

Aydon, steel screw steamer; built by the Blyth Shipbuilding and Dry Docks Company, Limited; to the order of Mr. J. E. Tully, Newcastle-on-Tyne; dimensions, 265ft., 38ft. 3in., and 19ft. 6in.; engines, triple-expansion, 20in., 33in., 54in. by 36in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company, Limited; the vessel is specially adapted for the coal and wood trade; trial trip, April 18th.

Matthew Flinders, steel screw steamer; built by Fleming and Ferguson, Limited, Paisley; to the order of the Queensland Government for pilot service work at the port of Brisbane; launch, recently.

Arapaima, twin-screw steamer; built by Phillip and Son, Limited, of Dartmouth; to the order of the Crown Agents for the Colonies; dimensions, 100ft. by 23ft. by 9ft.; to carry passengers in ferry service in British Guiana; engines, two sets compound surface condensing, pressure 140 lb. per square inch; launch, April 21st, 1914.

Egori, steel screw steamer; built by Harland and Wolff, Limited, Glasgow; to the order of Elder, Dempster and Co., Limited; dimensions, 419ft. 6in. by 54ft.; to carry cargo engines, triple-expansion; constructed by builders; launch, April 22nd, 1914.

Herschel, steel screw steamer; built by D. and W. Henderson and Co., Limited; to the order of Lamport and Holt, Limited, of Liverpool; dimensions, 450ft. by 55ft. by 30ft.; to carry cargo and passengers; engines, quadruple-expansion, 25½in., 36in., 51in., and 73½in. by 54in. stroke, pressure 215 lb. per square inch; constructed by D. and W. Henderson and Co., Limited; launch, April 23rd.

Boeroe, steel screw steamer; built by Wm. Gray and Co., Limited; to the order of the Netherland Steamship Company, of Amsterdam; dimensions, 433ft. 6in. by 54ft. 6in. by 36ft.; to carry cargo; engines, triple-expansion, 28in., 46in. and 77in. by 54in. stroke, pressure 180 lb. per square inch; constructed by the Central Marine Engine Works; trial trip, Saturday, April 25th.

Tamaha, steel screw steamer; built by Sir Raylton Dixon and Co., Limited; to the order of the Tank Storage and Carriage Company, Limited, of London; dimensions, 434ft. by 54ft. 6in. by 32ft. 8½in.; to carry 9250 tons on a light draught; engines, quadruple-expansion, 24in., 35in., 50½in., and 73in. by 51in. stroke, pressure 220 lb. per square inch; constructed by the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne; launch, April 25th.

Cornelis, steel screw steamer; built by Craig, Taylor and Co., Limited, Stockton-on-Tees; to the order of Mr. A. C. Lensen, of Terneuzen; dimensions, 306ft. by 45ft. by 22ft. 6in.; engines, triple-expansion, 21½in., 36in., 59in. by 39in. stroke, pressure 160 lb. per square inch; constructed by the North-Eastern Marine Engineering Company, Limited; a speed of 11 knots was attained on trial trip, April 30th.

Dykland, steel screw steamer; built by the Sunderland Shipbuilding Company, Limited; to the order of Fred Dughorn, Limited, of London; dimensions, 370ft. b.p. by 51ft. by 28ft. 9in.; to carry 7500 tons; engines, triple-expansion, 25in., 41in., and 69in. by 48in. stroke, pressure 180 lb. per square inch; constructed by George Clark, Limited, of Sunderland; a speed of 11¼ knots was attained on trial trip, May 2nd.

Elfland, steel screw steamer; built by the Northumberland Shipbuilding Company, Limited; to the order of Fred Dughorn, Limited, of London; dimensions, 380ft. by 51ft. by 28ft. 9in.; to carry 7500 tons; engines, triple-expansion, 25in., 41in., and 69in. by 48in. stroke, pressure 180 lb. per square inch; constructed by North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne; a speed of 11 knots was obtained on trial trip, May 2nd.

Sir William Matthews, twin-screw bucket ladder hopper dredger; built by Fleming and Ferguson, Limited, Paisley; to the order of the Crown Agents for the Colonies for the port of Colombo, Ceylon; launch, recently.

Panama, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Furness, Withy and Co., Limited, for the Empire Transport Company, Limited; dimensions, 400ft. by 52ft. by 29ft. 6in.; to carry 8000 tons on a moderate draught; engines, triple-expansion, 25in., 40in. and 68in. by 48in. stroke, pressure 180 lb. per square inch; constructed by Richardsons, Westgarth and Co., Limited; launch, recently.

Clay suction dredger; built by Werf Gusto, Firma A. F. Smulders, Schiedam, Holland; to the order of the Russian Government. The principal dimensions of the vessel are the following:—Length, 37 m.; breadth, 10 m.; depth, 3.300 m. It will be capable of sucking to a depth of 12 m., whilst the hourly output amounts to 1000 cubic metres. The sand pump is driven by a triple-expansion engine of 1200 horse-power, whilst another engine of 250 horse-power serves for driving the cutter.

## LETTERS TO THE EDITOR.

*(We do not hold ourselves responsible for the opinions of our Correspondents.)*

### THE "AERO TUG."

Sir,—In the report which you published in your last issue of the experiments with the aerially propelled tug, which is now lying at Staines, you say that the tug was the production of Messrs. James Pollock and Sons, Limited. Will you be good enough to allow me to correct this statement, since my syndicate is as fully responsible for the production of this tug as it was for the experiments carried out on the Surrey Canal, London, a little while back.

Messrs. Pollock can only be associated with the first aerially propelled tug as naval architects. Her hull was designed by them, and was built by Messrs. Tom Taylor and Sons, Limited, of Staines. Messrs. Pollock also supplied to the party for whom the tug was built a Bolinder engine, for which make of motor they are the agents in this country.

I wish to make clear that it is entirely through my syndicate that the construction of the tug was undertaken. That undertaking my syndicate could only do from the data it had acquired from the Surrey Canal experiments, and which data, I believe, I (its technical adviser) am still the only one to possess.

I hope you will be able to publish these few lines, as your account was not only misleading, but was unjust to me, who raised the whole question of the aerial propulsion of water craft for commercial purposes at the last meeting of the British Association, where my views were strongly criticised by many leading scientists who took part in the discussion which followed the reading of my paper.

Now that my views have proved to be correct, and that my syndicate has made it possible, by some considerable expenditure of money and much arduous work, to render the new method of propulsion of service to industry, I am naturally anxious that the syndicate should have full credit for the pioneer work it has done.

L. Blin Desbleds,
Technical adviser to the Aerial Propulsion Syndicate, Limited.

London, May 12th.

Sir,—It may interest your readers to know the conditions that were considered and reasons why the general design as shown in your illustration, page 508, were adopted in designing the oil-engined tug for the purpose desired.

It was necessary to put the aerial propeller about amidships to economise in the cost of working such a small craft. If it had been placed aft it would have necessitated an additional man to work the tug. The additional man to control the tow ropes aft would have also had a risky job to keep clear of the propeller.

As naval architects will appreciate, if the propeller was fitted aft it would be much more difficult to get the centres of gravity and trim arrangement satisfactory on such a light draught as 8in. without sacrificing speed and efficiency. With the propeller aft there would, of necessity, be a much longer line of shafting, an undesirable feature in a vessel of light construction with a high periphery speed of the propeller. I therefore decided to adopt the original design as shown on your excellent illustration, which has undoubtedly aroused the admiration of many eminent engineers, more especially in the results obtained.

As a result of the progressive trials, which occupied several days, my firm is prepared to guarantee speeds up to 10 miles per hour, draughts as low as 6in. static, and towing pulls not hitherto obtained with such craft.

There are no doubt many firms who would give great speeds for the "hydroplane" or "glider" type of vessel, but the conditions of the contract were, as indicated in your article, to produce an efficient, economical, and commercial vessel.

Stern wheelers, of which we have constructed a large number, could not be adopted because of the "wash" astern, and the probable sinking of the punts to be towed. Again, Messrs. Cornish and Berthon, the consulting engineers to the purchasers, would not accept screw propellers working in the water, either with or without tunnels, because of the difficulties of submerged objects, weeds, &c., and the liability of the immersed propellers getting damaged in such shallow waters as 13½in.

Walter Pollock,
London, May 11th. M.I. Mech. E., M.I.N.A., &c.

## FORTHCOMING ENGAGEMENTS.

### TO-DAY.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. "Plant Animals: A Study in Symbiosis," by Professor Frederick Keeble, F.R.S. At 9 p.m.

Keighley Association of Engineers.—The annual general meeting at the Assembly Room, Cycling Club, Cavendish-street, Keighley. 7.30 p.m.

### SATURDAY, MAY 16TH.

London Association of Foremen Engineers.—Visit to Dover. Victoria Station, South-Eastern and Chatham Railway, 7.45 a.m. Arrive at Dover Harbour Station, where the party will be met by Mr. A. T. Walmisley. Inspect Dover Marine Station now in course of construction, and the Admiralty Pier widening upon which this station is being constructed. 12.30 p.m., lunch at the Esplanade Hotel. Tug round harbour (high water 4.5 p.m.) Return to Prince of Wales Pier. See swing bridge at work across the Wellington Dock entrance.

The Institution of Municipal and County Engineers.—Meeting of the Institution in the Southern District at Salisbury. Reception in the Council Chamber. Papers by Mr. W. J. Goodwin, "Some Notes on the Municipal Works of Salisbury;" and Mr. J. H. Blizard on "The Bemerton and Wilton Pumping Station for Sewage Disposal." 11.30 a.m.

### WEDNESDAY, MAY 20TH.

Aeronautical Society.—Wilbur Wright Memorial Lecture. The second lecture will be delivered by Dr. R. T. Glazebrook, director of the National Physical Laboratory, at the Royal United Service Institution, Whitehall, S.W., at 8.30 p.m.

Royal Meteorological Society.—70, Victoria-street, Westminster. "The Reduction of Barometer Readings in Absolute Units, and a new Form of Barometer Card," by Mr. Ernest Gold; "A Cuban Rain Record and its Application," by Mr. A. Hampton Brown. 4.30 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. Ordinary meeting. "The Channel Tunnel and its Early History," by Mr. John Clarke Hawkshaw. 8.30 p.m.

### THURSDAY, MAY 21ST.

The Institution of Electrical Engineers.—Victoria Embankment, London, W.C. Annual general meeting. In the Lecture Theatre of the Institution at 5 p.m.

The Illuminating Engineering Society.—Annual meeting at the House of the Royal Society of Arts, John-street, Adelphi, London. "The Nomenclature and Definitions of Photometric Quantities," by Mr. A. P. Trotter. 7.30 p.m.

FRIDAY, MAY 22ND.

PHYSICAL SOCIETY OF LONDON.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. "Volatility of Thorium Active Deposit," by Messrs. T. Barratt and A. B. Wood; "The Passage of α Particles through Photographic Films," by Messrs. H. P. Walmsley and W. Makower; "On a Null Method of Testing Vibration Galvanometers," by Mr. S. Butterworth; "Experiments with an Incandescent Lamp," by Messrs. C. W. S. Crawley and S. W. J. Smith. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. "The Mortuary Chapels of the Theban Nobles," by Mr. Robert Mond. 9 p.m.

SATURDAY, MAY 23RD.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Visit to the works of Richard Garrett and Sons, Limited, at Leiston.

THURSDAY, MAY 28TH.

THE CONCRETE INSTITUTE.—Denison House, Vauxhall Bridge-road, S.W. The fifth annual general meeting, 4.30 p.m. The fourth annual dinner will take place on the evening of the same day at 8 p.m. at the Connaught Rooms, Great Queen-street, W.C.

THURSDAY, JUNE 4TH.

THE INSTITUTION OF MINING ENGINEERS.—In the Rooms of the Geological Society, Burlington House, Piccadilly, London, W. 11 a.m. The twenty-fifth anniversary of the foundation of the Institution will be celebrated at a dinner to be held at the Hotel Cecil in the evening, 7 p.m. for 7.15 p.m.

ENGINEERING GOLFING SOCIETY.—The spring meeting of the Engineering Golfing Society was held at Bramshot on Tuesday, the 12th inst., fifty-one members taking part in it. In the morning there was an 18-hole stroke competition in two divisions, members with handicaps of 10 and under being in the first division and those with handicaps of 11 and over in the second division. In the first division the President's Challenge Cup and Memento were tied for by Mr. W. E. Lane and Mr. Milbourne Williams, who both had a score of 89 – 8 = 81. The tie was played off in the afternoon, Mr. Lane winning and Mr. Williams taking the second prize. In the second division the Wilson Challenge Cup and Memento were won by Mr. Francis Wood, with 99 – 16 = 83, Mr. P. B. Brown being second with 98 – 13 = 85, after a tie with Mr. Carter and Mr. Goodman. In the afternoon there was an 18-hole bogey round, in which Mr. W. L. Mansergh (all square) won the first prize, the second prize being tied for by Mr. R. W. Hammond, Mr. G. N. Watney, and Mr. D. B. Butler, Mr. Hammond taking the prize, having returned the best score in the morning. The Scratch prize was tied for by Messrs. R. W. Hammond and C. H. Hayward with 84, who will play off on a future date. The Eclectic prize of the two rounds was won by Mr. C. H. Shortt with 77 – 4½ = 72½.

THE INSTITUTE OF METALS: MAY LECTURE.—The annual May lecture of the Institute of Metals was delivered by Professor E. Heyn, of Berlin, on Tuesday evening, at the Institution of Mechanical Engineers. In the course of his remarks Professor Heyn said that it was a well-known fact that the welfare and convenience of modern mankind was, to a very considerable extent, influenced by the achievements of the engineer. People admired his work and were daily confiding life and health to his creations. But only few were conscious of the fact that engineering work was, to a great extent, dependent on the possibility of manufacturing sound materials fit for the purpose and of keeping them sound in the course of the manifold processes that these materials had to go through until they were assembled into engineering structures. Certain structural members might fail even without being subjected to stresses in service. For instance, it had often been observed that condenser tubes made of brass cracked simply when stored up in the yard. Some articles made of this metal, when exposed to atmospheric influences, underwent an alteration to such an extent that they might be crumbled between the fingers. Similar phenomena could be observed in structural members made of other metals and alloys, when they were manufactured under unfavourable conditions, which led to serious internal strains. The author said that he had made a special study of the phenomena connected with internal strains, investigating their causes and devising a method for measuring their amount. In his lecture he dealt especially with the internal strains produced by cold working of metals—cold drawing, cold rolling, cold hammering, &c. He showed that by these operations under unfavourable conditions internal strains might be set up in structural members which came close to their resisting power, so that even trifling additional strains caused by external forces or other circumstances—scratching of the surface, unequal heating or cooling, slight corrosion by certain agents which were contained in the atmosphere or by certain paints—might lead to unforeseen fracture. He discussed the means for removing or diminishing such dangerous internal strains, and illustrated his lecture by numerous samples taken from practical engineering.

ROYAL INSTITUTION.—The annual meeting of the members of the Royal Institution was held on Friday afternoon (the 1st of May), The Duke of Northumberland, president, in the chair. The annual report of the Committee of Visitors for the year 1913, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The report of the Davy Faraday Research Laboratory Committee was read. Thirty-three new members were elected in 1913. Sixty-three lectures and nineteen evening discourses were delivered in 1913. The books and pamphlets presented amounted to about 289 volumes, making with 710 volumes (including periodicals bound) purchased by the managers, a total of 999 volumes added to the library in the year. Thanks were voted to the president, treasurer, and secretary, to the Committees of Managers and Visitors and to the Professors, for their valuable services to the Institution during the past year. The following gentlemen were unanimously elected as officers for the ensuing year:—President, the Duke of Northumberland; treasurer, Sir James Crichton-Browne; secretary, Mr. Alexander Siemens; managers, The Right Hon. Lord Blyth, Dr. Horace T. Brown, Mr. J. H. Balfour Browne, Mr. Charles Hawksley, Major Edmund H. Hills, Dr. Donald William Charles Hood, Sir Edwin Ray Lankester, Sir Alexander Mackenzie, Mr. Robert Mond, The Right Hon. Lord Moulton, Mr. Edward Pollock, Sir James Reid, Bart., The Right Hon. The Marquis of Salisbury, Mr. Alan A. Campbell Swinton, and Mr. Harold Swithinbank. Visitors, Mr. William R. Bousfield, Mr. Charles John P. Cave, Rev. Edward S. Dewick, Dr. William J. Gow, Mr. William A. T. Hallowes, Mr. John W. Jarvis, Mr. James Y. Johnson, Mr. H. R. Kempe, Dr. Adolph Liebmann, Mr. Carl E. Melchers, Dr. H. Forster Morley, Dr. F. W. Passmore, Mr. Charles E. S. Phillips, and Mr. A. J. Walter.—A general meeting of the members of the Institution was held on Monday afternoon, the 4th inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. Sir John H. Biles, Mr. R. C. Busselli, Mr. J. Carmichael, Mr. R. L. Cookson, Mr. M. S. Napier, and Miss K. O'Sullivan were elected members. The chairman announced that a legacy of £100 had been received from the executors of the late Mrs. Singleton. The special thanks of the members were returned to Mr. R. Pearce for his donation of £100 to the fund for the promotion of experimental research. The secretary announced that his Grace the President had nominated the following gentlemen as vice-presidents for the ensuing year:—Lord Blyth, Mr. J. H. Balfour-Browne, Mr. Charles Hawksley, Dr. Donald Hood, Lord Moulton, Mr. E. Pollock, Sir James Crichton-Browne, treasurer, and Mr. Alexander Siemens, secretary.

## THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

*(From our own Correspondent.)*

### Reduction in Steel Prices.

ALL the talk on 'Change in Birmingham this (Thursday) afternoon concerned the conference during the past few days between the Scottish, Midland, and North of England steelmasters and the important decision on prices thereat come to. The conference agreed to reduce the export prices upon steel plates 10s. per ton, and in some quarters this decision is construed as implying a like reduction or something of the sort in sections prices. Clearly the decision means carrying the competitive war into the enemies' camp, and herein lies its chief importance. It is understood on Birmingham Exchange that German, Belgian, and other continental competition has reduced the Scottish steel plate trade to the verge of ruin. As was anticipated in well informed circles would be the case, the Cleveland steelmasters' proposal to raise home trade prices was found by the conference to be absolutely impracticable. This suggestion therefore fell through.

### Midland Steel Makers and Conference Decision.

The importance of the 10s. reduction in export steel prices to Midland steel makers now resolved appears in the circumstance that, although Scottish makers have not been competing in England, the Midland industry has suffered by the diversion of contracts to Scotland which previously inevitably arose from the circumstance that Scotch home prices were 10s. per ton below those of makers on this side of the Tweed. English producers have lost business, and business which engineers have secured has had to be tendered for at a very low return.

### Raw Steel Trade.

There is no essential change this week in regard to raw steel. Some fairly good orders are being booked, but they come to hand spasmodically, and are not commensurate with productive capacity. Semi-products of home manufacture are quiet at £4 12s. 6d. to £4 17s. 6d. delivered Birmingham, with 2s. 6d. extra for Siemens. German agents are prepared to deal at about 5s. under the home rates.

### Pig Iron.

There is a fair demand for foundry pig iron, and smelters profess to discern signs of improvement in this direction. Prices, however, remain where they were last week. Some smelters are asking up to 50s. for Northamptonshire forge iron, but no business is being done at that figure, and 47s. 6d. is nearer the mark than the other end of the quotation, 49s. Northampton foundry iron realises 51s. to 51s. 6d. Comparing costs of production with the low selling prices ruling, it is evident that pig iron smelters are in a less favourable position than for a long time past. South Staffordshire common forge is quoted at 48s. to 49s., part-mine at 50s. to 51s., best Staffordshire all-mine forge at 85s. to 90s., best all-mine foundry at 92s. 6d., and cold blast at 125s. Derbyshire houses are open to do business in forge iron at 50s. 6d. to 51s. 6d. and upwards.

### Finished Iron Market.

The general reading of the finished iron market at Birmingham to-day was that small improvement can be looked for, at the earliest, before September. The strongest note is struck in the marked bar trade, prices being still maintained at their recent rate of £8 10s., with the Earl of Dudley's brand at £9 2s. 6d. Second-class bars are being taken up to a considerable tonnage, and employment in this department shows some improvement. Prices range from £6 10s. to £6 12s. 6d. delivered Birmingham. The lower grade iron which is used by the nut and bolt manufacturers of the Darlaston and Wednesbury district is sold at £6 2s. 6d. to £6 5s., which is 15s. to 17s. above the price at which Belgian houses are prepared to give supplies. Happily the home producer has still the pull in the market so far as small lots are concerned. German and Belgium material is being pressed on the market at very low rates, and the main reason why these cheap supplies are not being taken up much more largely is that consumers have not sufficient confidence in the future to commit themselves far beyond the hand-to-mouth buying for which the home market offers superior facilities. Makers of small rounds, squares, and flats have to contend with a very active competition from the Continent. The quotations for Staffordshire iron vary from £6 12s. 6d. to £6 15s. on the three-eighths basis. Imported material can be delivered at practically 10s. per ton below these figures.

### Tube Trade Matters.

The standard quotation of the Strip Manufacturers' Association has been reduced to bring it into something like correspondence with actual business. The nominal basis is now £6 10s. for lots of 25 tons and upwards, but this price is shaded where anything like good orders are in question. There is considerable unrest amongst the workmen in the wrought iron tube trade on union matters. This week 200 workmen employed at one of the tube works at Wednesbury have come out on strike as a protest against the employment by the firm in question of five men who are not members of any trades union. The leaders of the strike movement state that they are determined to compel every workman in the tube trade to fulfil the definite pledge given after the great strike of last summer to join the union. It would not be surprising under these circumstances if the Wednesbury strike spreads.

## NOTES FROM LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

### Little Change in Pig Iron.

THE attendance on the Iron Exchange on Tuesday could not be described as large, and there was a slow feeling to note in most departments. In pig iron there was little change. Business still continued on a limited scale, buyers being indifferent, even at the lower trend of prices. There was little or no change to note in either finished iron or steel. In copper, tubes showed a reduction. Sheet lead was unchanged, but English tin ingots advanced £2 per ton.

### Quotations.

Pig iron: Lincolnshire No. 3 foundry, 56s. 6d.; Staffordshire, 57s.; Derbyshire, 57s. to 57s. 6d.; Northamptonshire, 57s. 6d.; Middlesbrough, open brands, 60s. to 60s. 8d. Scotch, nominal: Gartsherrie, 68s. to 68s. 6d.; Glengarnock, 65s. 6d.; Eglinton, 64s.; Summerlee, 67s., delivered Manchester. West Coast hematite, 64s. 6d. to 65s.; East Coast ditto, 62s., both f.o.t. Delivered Heysham: Gartsherrie, 66s. to 66s. 6d.; Glengarnock, 63s. 6d.; Eglinton, 62s. 6d.; Summerlee, 65s. Delivered Preston: Gartsherrie, 67s. to 67s. 6d.; Glengarnock, 64s. 6d.; Eglinton, 63s.; Summerlee, 66s. Finished iron: Bars, £7 5s.; hoops, £7 12s. 6d. to £7 15s.; sheets, £8 12s. 6d. Steel: Bars, £6 7s. 6d. to £6 12s. 6d.; Lancashire hoops, £7 7s. 6d.; Staffordshire ditto, £8 5s. to £8 7s. 6d.; sheets, £9 to £9 5s.; boiler plates, £7 5s.; plates for tank, girder, and bridge work, £6 12s. 6d. to £6 15s.; English billets, £4 17s. 6d. to £5; foreign ditto, £4 5s. to £4 7s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, strips, &c., £79 per ton; small lots, 10d. per pound; rods, £77 per ton; small lots, 10d. per pound; tough ingots, £69 10s.; best selected, £69 10s. to £70 per ton copper tubes, 9¾d.; solid-drawn brass tubes, 7¾d.; brazed brass tubes, 9¼d. to 9½d.; condenser tubes, 8¾d.; condenser plates, 7¼d.; rolled brass, 7¼d.; brass turning rods, 6¾d.; brass wire, 7¼d.; yellow metal, 7½d. per pound. Sheet lead, £22 10s. per ton; English tin ingots, £159 per ton.

### The Lancashire Coal Trade.

There was only a moderate attendance on the Coal Exchange, and trade, in sympathy with the weather, was rather depressed. Inquiry for house coal appeared to be confined to immediate requirements only, but colliery owners showed no disposition to grant concessions to induce business. Slack and engine fuel were still weak, and for some odd lots sellers were willing to accept lower prices. There was also an easier feeling in shipping and bunkering coal, and whilst there was no official change to record, prices were occasionally 3d. to 6d. per ton lower. Quotations:—Best Lancashire house coal, 17s. 8d. to 18s. 10d.; good medium, 16s. 2d. to 17s.: domestic fuel, 13s. 5d. to 14s. 5d.; screened steam coal, 11s. 6d. to 13s.; slacks, 9s. to 10s. 9d. per ton at the pit.

BARROW-IN-FURNESS, Thursday.

### Hematites.

There is no change of moment to record in the hematite pig iron trade. Throughout the district there is activity at the works and a large volume of iron is being produced. In Cumberland there are fourteen furnaces in blast and in North Lancashire eight, and the whole of the output is going into immediate consumption, these orders having been secured by makers some time ago. In the demand for iron there is no improvement to note, and new business is rather slack in coming to hand, there being no disposition on the part of users to place respectable contracts. Prices are much the same, with mixed numbers of Bessemer iron quoted at 66s. to 67s. per ton net f.o.b. For special brands there is a steady demand at 72s. to 74s. per ton net. There is nothing being done in warrant iron, and the quotation still stands nominally at 61s. per ton net cash.

### Iron Ore.

The iron ore trade is well employed. On local account there is a large consumption of metal, and on shipping account a good business is being done as between Cumberland raisers and Scotch smelters, and ore is also being sent from Barrow to Glasgow, Dee ports, &c., but the quantity is not large. The boring operations about to be commenced near Askam-in-Furness are creating considerable interest in the Furness district. Various attempts have been made to find ore thereabouts, but the search has not been successful so far. The place where boring is to take place is some three miles from the famous Hodbarrow pits, but on the Lancashire side of the river Duddon. The importations of Spanish ore continue to be steady and the current value is 16s. to 17s. per ton delivered.

### Steel.

In the steel trade the activity industrially is not so marked as has been the case. At the Barrow Steel Works the rail mills are not fully employed, but at the same time a good output of rails is being maintained. The rail mills at Workington are busy. The manufacture of plates at Barrow is fairly heavy, but No. 1 mill is off, whilst some alterations are being made. The hoop departments at Barrow are busy. The demand for steel rails is steady, but by no means satisfactory, and prices are easy with heavy sections at £5 17s. 6d. to £6 2s. 6d. per ton. There is only a limited trade on offer in light sections of rails, and these are quoted at £6 17s. 6d. per ton, which is also the nominal value of heavy tramway rails. For steel shipbuilding material there is a steady request. Ship plates are at £6 10s. to £6 15s. and boiler plates at £7 10s. to £7 15s. per ton. Heavy shipbuilding castings are in fairly strong request. Hoops are a fair business at £8 5s. per ton.

### Shipbuilding and Engineering.

These trades present no new features. In every department there is activity. Tenders are being prepared for the new battleships for the British Government which are to be given out shortly. Much progress is being made in the construction of the new airship works on Walney Island, and in the meantime the airship staff is busy on its plans, &c., whilst a quantity of material for the first airship has already been received.

### Fuel.

There is a good demand for coal, and steam sorts are quoted at 15s. to 17s. per ton delivered. Coke is in steady request at 19s. 6d. to 21s. 6d. per ton delivered for East Coast sorts, 18s. for Lancashire coke, and Welsh coke is quoted at 20s. per ton delivered.

## THE SHEFFIELD DISTRICT.

*(From our own Correspondent.)*

### No Slump Yet.

THE Board of Trade figures for April appear to have rather got upon the nerves of some of the iron and steel manufacturers in the Sheffield district. With the exception of new ships, everything in which Sheffield is directly or indirectly concerned showed considerable decreases, and that seems to have given the keynote to reports made to me in one quarter and another during the past week. If one listened entirely to these reports it would be to believe that the whole district is just about to enter a period of gloomy slump. It is undoubtedly the case that many firms are feeling badly a falling off in new business, and slack time is by no means uncommon amongst the workers. Even some of the very large firms are suffering in that way, and moulders, for instance, are being "suspended" in batches for indefinite periods. Where the pinch is chiefly being felt is in the case of firms specialising on certain manufactures for which the market has gone flat, whilst on the other hand, those with departments more easily adaptable to various requirements are now reaping the benefit of their wider policy. Hearing so many gloomy opinions expressed as to the outlook I have carefully analysed the position during the week, and find that things are not really as bad as represented. There certainly is a lull in new orders and the situation is not very reassuring, but many leading manufacturers take a perfectly hopeful view, believing that as the present tendency has been more or less in existence for the past twelve months, the cessation of orders must sooner or later result in new business coming forward. The delay in a complete settlement and development of the Balkans, the state of unrest in Mexico, and political troubles at home are very adverse features, but even after making allowance for all these, there are honestly no signs of anything like a serious slump. On the contrary, some departments of the steel trade are very well placed. For instance, railway material for abroad and train material for home are both quite active, and whilst tool steel departments are working much below their possible output and Germany's requirements have thinned out, Russia is buying such things as saws and agricultural steel pretty freely. Shell-making departments appear to be easing off rather, though, generally speaking, the armament firms are all well employed, and South African and Indian orders for industrial work are coming in fairly freely. In armour plate, however, important deliveries to Italy and Spain appear to be hanging fire.

### Pig Iron.

In the pig iron markets a curious point not generally noticed is that in a few isolated instances deliveries are still being made on contracts fixed two years ago, when trade was at

the height of a boom. For a long time, however, consumers have been adopting a cautious policy, and are very chary about forward buying. As a rule there are few contracts arranged beyond the end of next month, and so hopeful are consumers of a fall in prices that they are content to keep on the open market. If anything, there is perhaps a slight weakening in the pig iron position, though not to the extent of a change in quotations, for makers seem more inclined to restrict output by putting out furnaces than to drop prices below a level which they declare is already unremunerative. The makers' position is strengthened by reason of the almost entire absence of stocks either at their yards or at consumers' works, all the iron made going at once into consumption. The demand for special makes of West Coast hematite keep fairly brisk, but ordinary qualities are dull at about 73s., and East Coast mixed numbers are in much the same position at about 68s. net Sheffield. In common irons there are a few inquiries about, but usually for only small quantities. Lincolnshire forge is quoted at 53s. 8d., foundry at 54s. 6d. to 55s., and basic about 55s. 8d., whilst for Derbyshire makes forge is quoted at about 50s. 6d., with little business passing, and foundry at about 5s. more.

### Billets and Bars.

Billets appear to be in rather a poor way. The better qualities of acids find a fair market, though there is much competition, the quotation for ordinary makes being about £6 10s. to £6 15s. for Bessemer and £6 15s. to £7 for Siemens. Business in basic billets is quite flat, local makes still being hard pressed by continental stuff. Local hard basic is quoted at £5 10s., and dead soft at £4 15s., the latter comparing with foreign softs at 84s. The difference of 11s. is largely discounted by the fact that foreign stuff has to be taken cash down on the bill of lading, whilst buyers of local billets have an opportunity of examining the trucks and rejecting them if not as per contract. It is now about a year since railways or private firms gave out any orders of consequence for wagons—it is doubtful if 1000 have been ordered locally in that period. For that reason bar iron remains under a cloud, though the fact that every week now brings makers nearer to the time when such orders will have to be placed again has created a spirit of hopefulness. The price of crown bars has fallen from £9 to £7 5s., but so far none of the reductions has succeeded in bringing the business expected. Foreign bars also are being imported.

### Round the Works.

Notwithstanding the general lull in trade, inquiries show that a fair number of new orders has been booked. The Central Argentine Railway has given out contracts to eleven Sheffield firms, the requirements including tools, tires, glazed material, stone crushers, wire ropes, carriage vestibules, files (two orders), steel and axles, springs and pins and axles. For work in connection with the extension of the London Docks the Port of London Authority has placed an order here for 100 tons of glass. The East India Railway has given contracts to three firms for fair tonnages of spring steel, tires, and axles, and for shipment to South America one firm is making about 40 tons of tires. Hadfield's, Limited, have secured an order from the Johannesburg Municipality for tramway points and crossings to the value of £1211 15s., and for the London United Tramways one of the works here is making 4000 tie bars. Edgar Allen and Co. have had a tender accepted by the Aberdeen Corporation Tramways Committee for the supply of special track work to the value of £1063.

### Fuels.

Coal at the present time is in very fair demand, chiefly on contracts taken some time ago, and there is a very considerable tonnage going for shipment, though perhaps not to the same extent as at this period last year. Very few pits are now working anything but full time, and the output from South Yorkshire is steadily on the increase, new fields being in process of development. The quotations of steam coal at the pit are from 10s. 6d. to 11s. 6d. per ton. The supply of coke is still larger than the demand, but prices during the past week have been firmer than of late. Patent coke stands at from 10s. 6d. to 11s., and best beehive from 11s. to 11s. 6d. at the ovens.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Cleveland Iron Trade.

The outlook in the Cleveland iron trade is far from reassuring. The rather better position as regards buying last month has been succeeded by renewed flatness, and while a fair, steady trade of a small character continues to be done, consumers are not disposed to commit themselves far ahead. Buying to cover requirements for the summer months up to July proceeds quietly, but beyond that period little or no interest is being taken. In the meantime it is gratifying to note that the output is being sold and that it is, in fact, insufficient to meet the demand, as shown by the daily withdrawals of iron from the public warrant stores. This is a direct result of the strict limitation of the output. The steadiness of the Cleveland market is maintained solely by the strong statistical situation. But the outlook, even in existing circumstances, is uncertain, and it is complicated by the continued unremunerative character of production. Costs are still too high, and until there is further relief in this direction Cleveland iron must remain comparatively dear and competitive trade handicapped. The Cleveland iron market has been described as the only firm iron market in the world at the present time, but it has to be remembered that the margin of profit here is always, generally speaking, lower than elsewhere. The total number of furnaces at present in blast in the North of England is seventy-four. Of this total forty are producing Cleveland iron, twenty-five hematite, and nine special kinds of iron. The general market quotation for No. 3 G.M.B. Cleveland pig iron is 51s. 7½d. f.o.b., whilst No. 1 is 54s. 1½d.; No. 4 foundry, 51s. 3d.; No. 4, forge, 50s. 9d.; and mottled and white iron, each 50s. 3d., all for either early or forward delivery.

### Hematite Pig Iron.

The market for hematite has been on the quiet side during the past few days and transactions have been only of moderate amount. In consequence of the slackness in the steel trades prices show a downward tendency, and there are keen sellers of East Coast mixed numbers at 61s. 3d. for practically any delivery. The general quotation for No. 1 hematite is 61s. 9d. At the moment the output is going steadily into consumption, steel makers in the immediate district accounting for the largest proportion of the tonnage.

### Iron-making Materials.

The foreign ore trade remains dull and lifeless. Consumers still refrain from placing further orders and a quieter time for the ore merchants has not been known for a very long time. For Rubio ore of 50 per cent. quality the price continues nominally at 17s. 6d. per ton ex ship Tees. Coke is very scarce with a rather heavy pressure for deliveries, and the price of good medium furnace qualities is firmer than ever at 17s. 3d. delivered at the works, while some sellers refuse to entertain anything below 17s. 6d.

### Manufactured Iron and Steel.

The position of the finished iron and steel trades of the North of England has not altered to any very material extent during the past week. In the steel trade there is no actual lack of work. The makers give very smart delivery, however, compared with what they were able to do some time ago. The important fact, however, is that fresh contracts for steel material are getting of less importance, and this points in the direction of a quieter state of trade in the not very distant future. The trade buying of finished iron shows not the least sign of expansion, makers having to contend against keen competition by continental producers, from whom large quantities are obtainable at far below the prices for which British material is held. Makers of the higher grades of material hold a moderate tonnage on their order books, but the common sorts are in very indifferent request. The following are the principal market quotations:—Common iron bars, £7; best bars, £7 7s. 6d.; best best bars, £7 15s.; packing iron, £6 5s.; iron ship angles, £7; iron engineering angles, £7; iron ship plates, £6 15s.; iron girder plates, £7 5s.; iron ship and girder rivets, £8; steel bars, basic, £6 5s.; steel bars, Siemens, £6 15s.; steel ship plates, £6 7s. 6d. to £6 10s.; steel boiler plates, £7 10s.; steel ship angles, £6 2s. 6d. to £6 7s. 6d.; steel engineering angles, £6 17s. 6d. to £7; steel sheets, singles, £8 5s.; steel sheets, doubles, £8 10s.; steel joists, £6 12s. 6d.; steel hoops, £6 10s.; steel strip, £6 5s., all less the usual 2½ per cent. f.o.t. Heavy steel rails, £6; steel railway sleepers, £7 5s.; light iron rails, £7, all net at works. Cast iron chairs, £4 5s.; cast iron pipes, 1¼in. to 2in., £6 7s. 6d.; 3in. to 4in., £6; 5in. to 8in., £5 15s.; 10in. to 16in., £5 17s. 6d.; 18in. to 24in., £5 17s. 6d.; cast iron columns, plain, £7 7s. 6d.; floor plates, £3 10s. to £3 12s. 6d., f.o.r. at makers' works. The galvanised sheet trade is exceptionally quiet, makers experiencing great difficulty in obtaining orders. The market quotation for sheets of 24 gauge is £11 5s. per ton, less the usual 4 per cent.

### Shipbuilding and Engineering.

In spite of the depression in freights and in spite also of the large amount of tonnage still under construction, there is a fair number of inquiries for new vessels. It is true that the demand for new "tramp" tonnage has fallen off very much, but there are still inquiries for vessels of special types. Several railway and shipping companies, for instance, are inviting tenders for passenger or cargo and passenger vessels, and orders are expected to be placed very shortly. This week contracts for two cargo boats and a pilot cutter have been placed with North-East Coast builders. There is in the different sections of the engineering trades a good supply of work. This is particularly the case in the marine department. Locomotive builders are also well employed and the general trades have good employment. It is understood that the Royal Siamese State Railway has placed a contract with the Cleveland Bridge and Engineering Company, of Darlington, for no fewer than forty-three small open lattice type girder bridges of various dimensions ranging up to 190ft. in length. The contract has been secured in face of keen foreign competition from Belgium, Germany, and the United States.

### Coal and Coke.

There is a fairly active business passing in the coal market, but supplies are plentiful, and in most cases buyers are able to secure concessions. The Spanish strike has thrown large quantities of Durham coking coal into the market, and prices have tended to weaken. The forward inquiry for coal is good. It is reported that Russia is inquiring for about 60,000 tons of coal for the railways, delivery during the next two months, while the French naval authorities are in the market for a large tonnage. Best Durham gas coal is quoted at 13s. 6d., while second qualities are 12s. 6d. to 13s. Bunker coals are quiet and irregular, some brands being difficult to secure at any prices, while other grades are in excess of requirements. Business has been done this week in ordinary Durham bunkers at 11s. 6d. and 12s. 3d., and best qualities at 12s. 9d. to 13s. Steam smalls are scarce and strongly held. The demand for coke is strong and prices firm. Quotations are:—Gas coke, 13s. 6d. to 13s. 9d.; foundry coke, 19s. to 20s.; and furnace coke, 17s. 6d.

## NOTES FROM SCOTLAND.

*(From our own Correspondent.)*

### The Warrant Market.

The Glasgow pig iron warrant market has been quieter than ever during the week, and the total turnover did not exceed 4500 tons. In the absence of business, quotations did not fluctuate to any extent, and the closing prices were only a trifle easier than in the preceding week. Cleveland iron closed at 51s. 2½d. per ton cash buyers, 51s. 4½d. one month, 51s. 6d. three months.

### Pig Iron.

The general trade position in pig iron has not improved, and, although in one or two instances makers have made fairly good deliveries of ordinary qualities, business with consumers is on a very meagre scale, and inquiries are scarce. There are 72 furnaces in blast in Scotland, the same number as in the preceding week and 20 fewer than in the corresponding week of last year. The import of pig iron into Grangemouth from Middlesbrough and district during the week reached the total of 6275 tons.

### Quotations.

The prices of Scotch makers' iron are unchanged, and are as follows:—Monkland, f.a.s. at Glasgow, No. 1, 62s.; No. 3, 60s. 6d.; Govan, No. 1, 61s.; No. 3, 60s.; Carnbroe, No. 1, 66s. 6d.; No. 3, 62s. 6d.; Clyde, No. 1, 68s.; No. 3, 63s.; Gartsherrie, Summerlee, Calder, and Langloan, Nos. 1, 68s. 6d.; Nos. 3, 63s. 6d.; Glengarnock, at Ardrossan, No. 1, 71s.; No. 3, 66s.; Eglinton, at Ardrossan or Troon, No. 1, 62s.; No. 3, 61s.; Dalmellington, at Ayr, No. 1, 63s.; No. 3, 61s.; Shotts, at Leith, No. 1, 68s. 6d.; No. 3, 63s. 6d.; Carron, at Grangemouth, No. 1, 69s.; No. 3, 64s. per ton.

### Finished Iron and Steel.

There is nothing fresh to report so far as regards the Scotch steel trade in general. Specifications for plates continue to be very scarce, and short time is being experienced at the majority of the mills. Sectional makers, however, while not quite so well employed as formerly, are better off for orders than plate makers, and employment is fairly steady. The export demand is quiet, and buyers are evidently holding off in the anticipation of further reductions in quotations. Some consumers are inclined to cover their future requirements, but manufacturers are not disposed to book ahead at the present rates. Galvanised and black sheet makers are comparatively well employed, and, while fresh business is not easily obtained, the works on the whole are running steadily. There is no improvement in the malleable iron trade, and the recent cut in prices has not as yet brought out any increase in the volume of business, and there is no abatement in the keen foreign competition which has so adversely affected this trade for some considerable time back. Wrought iron and steel tube makers could also do with a large increase in the quantity of business passing.

### Steel Prices.

It is reported that at a conference of the Scottish and English Steelmakers' Association held in London during the week it was decided to reduce the export price of plates by 10s. per ton.

### Scotch Coal Trade.

There has been no further development in the coal trade, and business is in much the same position as in the preceding week. In the West of Scotland district the market is quiet, and most qualities of coal are in moderate demand, while the best brands of ell and splint are active at firm prices. Business in the Lothians and Fifeshire is on a satisfactory basis, and there is a good all-round demand, with the strong shipping demand the principal feature. Ell coal is quoted, f.o.b. at Glasgow, 12s.; splint, 11s. 3d. to 13s. 9d.; navigation, 14s. 6d. to 15s.; steams, 11s. to 13s.; treble nuts, 11s. 9d. to 12s.; doubles, 11s. to 11s. 6d.; singles, 11s. to 11s. 3d. per ton.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### Cardiff Coal Market.

There has been quite a pronounced deterioration in the strength of the Cardiff coal market during the past few days. A marked change has come over the market compared with a week or a fortnight ago, when a buoyant tone prevailed and coals were practically unobtainable, in some cases, at any price. Since then, however, orders have become scarce, and the tonnage question has asserted itself to the detriment of business. The holding up of Spanish vessels on account of the strike of officers and engineers has accentuated the shortage of tonnage supplies, and as chartering has during the past week or more gradually fallen off, the outlook has become sombre compared with recent times, notwithstanding that the Whitsuntide holidays come along in a fortnight's time. The collieries as a whole were fairly well placed for this week, and prompt supplies have been difficult, but for next week fears that the tonnage will not be up to requirements have induced a weaker tone all round. There has not been much of a falling off in actual quotations, but the position is that they are little more than nominal, and there is no business passing at the figures quoted, while wherever possible buyers are deferring placing orders, in expectation of more favourable terms being obtainable later. Small coals have eased to some extent as well as large descriptions. Patent fuel remains steady, while pitwood has improved. Steam coal: Best Admiralty large, 19s. 6d. to 19s. 9d.; best seconds, 18s. 3d. to 18s. 9d.; seconds, 17s. 3d. to 17s. 9d.; ordinaries, 16s. 6d. to 17s.; best drys, 18s. to 18s. 3d.; ordinary drys, 16s. to 16s. 6d.; best bunker smalls, 10s. 9d. to 11s.; best ordinaries, 10s. 3d. to 10s. 6d.; cargo smalls, 8s. to 9s.; inferiors, 7s. to 7s. 9d.; washed smalls, 12s. to 12s. 6d.; best Monmouthshire black vein large, 17s. to 17s. 6d.; ordinary Western Valleys, 16s. 9d. to 17s.; best Eastern Valleys, 16s. to 16s. 3d.; seconds, Eastern Valleys, 15s. 6d. to 15s. 9d. Bituminous coal: Best households, 19s. to 20s.; good households, 17s. to 19s.; No. 3 Rhondda, large, 17s. 6d. to 18s.; smalls, 12s. to 12s. 6d.; No. 2 Rhondda, large, 13s. 6d. to 14s.; through, 11s. 6d. to 12s. 6d.; smalls, 9s. to 9s. 6d.; best washed nuts, 16s. to 16s. 3d.; seconds, 14s. 6d. to 15s.; best washed peas, 14s. 6d. to 15s.; seconds, 13s. 6d. to 13s. 9d. Patent fuel, 19s. to 21s. Coke: Special foundry, 28s. to 29s.; good foundry, 22s. to 25s.; furnace, 17s. to 19s. Pitwood, ex ship, 19s. 6d. to 20s.

### Newport (Mon.).

Monmouthshires have slackened off considerably this week, and apart from the influence exerted by the shortage of tonnage supplies, the resumption of work at the Ebbw Vale pits on Monday last had the effect of weakening prices. The inquiry has been very quiet, and very little business has been passing either for prompt or backward positions. Small coals, however, have maintained a very steady tone, and recent figures have been fairly well upheld. Steam coal: Best Newport black vein, large, 17s. to 17s. 6d.; Western Valleys, 16s. 9d. to 17s.; Eastern Valleys, 16s. to 16s. 3d.; other sorts, 15s. to 15s. 6d.; best smalls, 8s. 6d. to 9s.; seconds, 8s. to 8s. 3d. Bituminous coal: Best house, 18s. to 19s.; seconds, 17s. to 18s. Patent fuel, 19s. 9d. to 20s. Pitwood, ex ship, 19s. 6d. to 20s.

### Swansea.

Slackness has been much in evidence in the anthracite market during the past week, the expected improvement in business not having manifested itself so far. With shortage of tonnage the prospects are not very cheerful for the time being. The demand for Swansea Valley large has been a little more active, but red vein large has been dull. Machine-made nuts and cobbles remain fairly steady, and quotations are adhered to for rubbly culm. As regards steam coals, smalls have been well inquiried for, but other descriptions are easy. Approximate values:—Anthracite: Best malting, large, 22s. to 23s. net; second malting large, 18s. to 19s. net; big vein, large, 16s. 3d. to 17s., less 2½ per cent.; red vein, large, 13s. 3d. to 14s. 3d., less 2½ per cent.; machine-made cobbles, 21s. 6d. to 23s. net; French nuts, 22s. to 23s. 6d. net: German nuts, 22s. to 23s. net; beans, 15s. 9d. to 17s. 3d. net; machine-made large peas, 10s. 9d. to 12s. 3d. net; rubbly culm, 6s. to 6s. 3d., less 2½ per cent.; duff, 4s. 6d. to 5s. net. Steam coal: Best large, 18s. 6d. to 20s., less 2½ per cent.; seconds, 14s. 9d. to 15s. 9d., less 2½ per cent.; bunkers, 11s. 3d. to 12s. 3d., less 2½ per cent.; smalls, 8s. to 8s. 6d., less 2½ per cent. Bituminous coal: No. 3 Rhondda, large, 17s. to 18s., less 2½ per cent.; through and through, 14s. to 15s., less 2½ per cent.; smalls, 10s. 9d. to 11s. 9d., less 2½ per cent. Patent fuel, 17s. to 17s. 6d., less 2½ per cent.

### Tin-plate and other Quotations.

I.C., 20 × 14 × 112 sheets, 12s. 9d.; I.C., 28 × 20 × 56 sheets, 13s.; I.C., 28 × 20 × 112 sheets, 25s. 6d.; I.C., ternes, 28 × 20 × 112 sheets, 22s. 3d. to 22s. 6d.; finished black plates, £9 10s. per ton; galvanised sheets, 24 g., £10 17s. 6d. to £11 per ton. Block tin, £152 17s. 6d. per ton cash, £154 15s. per ton three months. Copper, £63 5s. per ton cash, £63 15s. per ton three months. Lead: English, £18 15s. per ton; Spanish, £18 10s. per ton. Spelter, £21 7s. 6d. per ton. Silver, 27d. per oz.

### Iron and Steel Trades.

Pig iron: Standard iron, 51s. cash, 51s. 1d. month; hematite mixed numbers, 61s. cash, 61s. 1d. month; Middlesbrough, 51s. 4½d. cash; 51s. 5½d. month; Scotch, 57s. 4½d. cash, 57s. 5½d. month; Welsh hematite, 66s. 6d. to 67s. dd.; East Coast hematite, 66s. to 67s. c.i.f.; West Coast hematite, 66s. 6d. to 67s. 6d. c.i.f. Steel bars: Siemens, £4 11s. 3d. per ton; Bessemer, £4 10s. per ton. Steel rails, heavy sections, £6 10s. per ton. Iron ore: Rubio, 17s. 3d. to 17s. 6d.

## PERSONAL AND BUSINESS ANNOUNCEMENTS

Hurst, Nelson and Co., Limited, of Motherwell, ask us, in view of erroneous reports having been circulated with regard to the extent of the destruction caused by the fire at their Glasgow rolling stock and plant works at Motherwell on April 27th, to state that the fire was confined almost entirely to their carriage building shops, and that temporary arrangements are being made to carry on car and carriage work until the buildings destroyed by fire are rebuilt.

The City and West End Drawing-office, of Fleet-street, Bush-lane House, Cannon-street, and Pembroke House, Oxford-street, announces that the lease of its offices at 57, Fleet-street, having been acquired by the Corporation of the City of London, in connection with the widening of Fleet-street, it has removed to new offices at 186, Fleet-street, a few yards further west on opposite side. The telephone number will remain the same, namely, 5974 Central.

## NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

*(From our own Correspondent.)*

### Rheinland-Westphalia.

THE position generally of the iron and steel market over here has remained quiet. The majority of the mills and factories are pretty regularly occupied. The heavy industries in particular report themselves well engaged, but prices are low, with no prospect of improvement for the present. Deliveries in the various branches are stated to be well up to the average. Accounts given by the Steel Convention show sectional iron to be in rising demand, while only a normal business is being done in rails and railway material, and in semi-finished steel. A slow trade goes on in drawn wire, because a further decision is awaited regarding the prolongation of the Convention; if no agreement has been arrived at by May 15th the mills will be justified in doing business up to and beyond July 1st independently of the Convention. Quietness prevails in bars, M.93 to M.94 p.t., free Oberhausen, having been quoted in some instances, while the official quotation last week was M.94 to M.97 p.t., compared with M.95 to M.98 p.t. last month. Basic hoops are quoted M.115 to M.120 p.t., as compared with M.116 to M.121 p.t. Heavy plates stand at M.99 to M.102 p.t., as compared with M.100 to M.103 p.t.; boiler plates, M.109 to M.112 p.t., as compared with M.110 to M.113 p.t; sheets, M.115 to M.120, as compared with M.117 to M.121 p.t.; but both heavy plates and sheets may be bought for less, makers being willing to grant concessions. In the shipbuilding industries occupation remains satisfactory, existing orders securing employment up to the end of this year. Prices are considerably influenced by competition. Dealers in and consumers of pipes are buying a little more freely now, being desirous to cover their demand while the low prices are ruling. Regarding the hardware and tool industries, reports during the past few weeks have been a little more favourable; the cutlery department in particular shows improvement with regard to demand. Prices in the other departments are below the average.

### Output of Pig Iron.

According to figures given by the Union of German Iron and Steel Masters, the production of pig iron in Germany, including Luxemburg, for April, 1914, was 1,534,429 t., as compared with 1,602,896 t. in March and 1,588,701 t. in April, 1913. Daily output was 51,147 t. for April this year, as compared with 51,706 t. in the previous month and 52,957 t. in the same month in 1913. Production in the different sorts of pig iron was as follows:—Foundry pig, 266,787 t., as compared with 300,113 t. in April last year; Bessemer, 35,383 t., as compared with 24,255 t.; basic, 1,004,306 t., as compared with 1,014,572 t.; steel and spiegeleisen, 194,238 t., as compared with 208,169 t.; forge pig, 33,715 t., as compared with 41,592 t. in April, 1913. Output during the period from January 1st to April 30th this year was 6,149,690 t., as compared with 6,323,386 t. in the corresponding period last year.

### The German Coal Market.

Inland consumption is moderate, while exports have been increasing. Coke remains in poor request.

### Austria-Hungary.

Throughout the country producers are poorly occupied, and rates have again been tending downwards in raw and finished iron. Coal has been in satisfactory demand.

### Weak Tone in Belgium.

All hopes for an improvement during the present quarter seem to have vanished, and depression prevails in the various trades. Quotations are complained of as leaving no profit, and the working hours are restricted at many establishments. A very limited business is being done in pig iron, and prices are weak, although for foundry pig a little more firmness is experienced, owing to better inquiry. Imports of pig iron decreased during the first quarter, 91,632 t. being imported, as compared with 203,775 t. in the year before. Besides the above decrease of 55 per cent. in imports, inland production of pig iron also showed a falling off of 20,000 t.; so the total decrease in consumption amounts to 132,413 t. The business in scrap iron is absolutely lifeless; the contracts on offer in semi-finished steel are keenly competed for; rolled billets stand at 71s. p.t. f.o.b. Antwerp. An irregular and rather poor business is being done in merchant bars, rates varying between £4 2s. and £4 3s. p.t. for export, while the inland price is 112.50f. p.t. Iron bars stand at £4 8s. p.t. for export and 122.50f. p.t. for home consumption. Disappointing accounts are given of the plate department; 127f. to 130f. p.t. is quoted for ¼in. plates, the export price being £4 14s. p.t. Rolls have gone down to £4 13s. p.t. Hoops are firm. The coal market in Belgium is weak, and prices are tending downwards in many cases. Coal for coke making is exceedingly neglected. There is talk of the Coke Syndicate intending to reduce rates about 1.50f. p.t. In briquettes a lifeless tone is also complained of.

## AMERICAN NOTES.

*(From our own Correspondent.)*

NEW YORK, April 29th.

The iron and steel situation can be best understood when it is known that the railroads of the United States, which normally consume about 60 per cent. of mill products, are taking about 25 per cent. Traffic requirements, at least as to crops, are increasing, but the railroads hold back, even to delaying extensions of existing lines and branches. Railroad and other shops have scarcely any steel. Notwithstanding quite heavy imports of tin-plate, American tin-plate mills are running to capacity. The Standard Oil interests are contracting for 10,000,000 lb. of tin-plate for export cans. Should war develop in Mexico canned goods will be in great demand, with corresponding improvement in the demand for tin-plates. Bars, plates, and shapes are 1.15 at mill in large lots, but this week some mills began filling car lot orders at this figure. Rail contracts were closed for 23,600 tons, of which 20,000 tons are for the Northern Pacific. Locomotive orders for the week, fifty-three, against thirteen week before, and 4966 cars and underframes. General structural contracts took 22,650 tons, of which 8000 tons were for the Bethlehem Steel Company's dock and pier, 4000 tons for use in Pittsburgh, and 2225 tons for a Massillon, Ohio, rolling mill. About one-half as much pig iron will be bought this month as in March. About 4000 tons are for export. Receipts of Nova Scotia pig iron, 3500 tons. Contracts have been placed for 20,000 tons additional to be imported during May and June. The need of rolling stock to handle increasing freight has brought out inquiries among the car builders for some 25,000 or 30,000 cars. Much bridge work is coming up and the business will be placed. The Washington and Southern ordered this week 2100 tons, the Chicago Viaduct 2000 tons. Copper is quiet. Exports so far 25,768 tons. Larger exports are anticipated. A feeling of unrest prevails. Large domestic transactions are not in sight. Production is fully maintained.

## BRITISH PATENT SPECIFICATIONS.

*When an invention is communicated from abroad the name and address of the Communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 8d. each.*

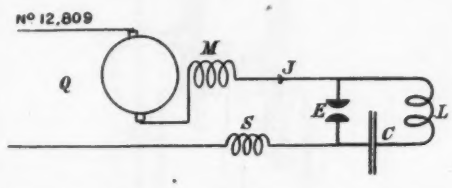
*The date first given is the date of application: the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete Specification.*

*Any person may, on any of the grounds mentioned in the Act, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of any Patent.*

### TELEGRAPHS AND TELEPHONES.

12,809. June 2nd, 1913.—IMPROVEMENTS IN AND RELATING TO GENERATORS FOR HIGH-FREQUENCY CURRENTS, Emile Girardeau, of 128, Rue La Boetie, Paris, France.

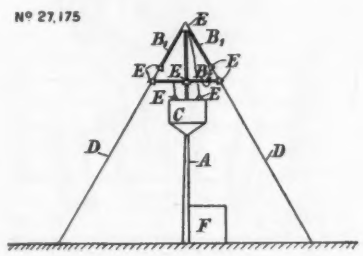
In accordance with this invention there is provided between the source Q and the discharger E, to the terminals of which the oscillatory circuit E C L is branched, a continuous-current machine M provided with series excitation and acting as a motor. In these circumstances such a machine will be the equivalent of an ohmic resistance and further it has a certain inductance. This inductance is not prejudicial and it enables the value of the self-induction S, usually switched on the charging circuit with a view to prevent the passage of high-frequency currents through the supplying circuit, to be reduced. The mechanical energy




on the shaft of machine M may be disposed of at will and changed back, if desired, into electrical energy again by coupling the machine, for example, with one of the generators which supply the discharger E. In the latter instance the generator which supplies the discharger E will be provided with a field winding, which is separately excited, as is generally the case in similar plants. It is therefore evident that the two armatures of the generator supplying the discharger and the machine M which are coupled mechanically and are electrically connected in series may be combined in one armature. There are two other illustrations.—*April 22nd*, 1914.

27,175. November 25th, 1913.—IMPROVEMENTS IN OR RELATING TO RADIO-TELEGRAPH STATIONS, *Signal Gesellschaft, m.b.H., of Werk Ravensberg am Habsburger Ring, Kiel, Germany.*

In fitting aerial apparatus, and especially flying machines, with radio-telegraph stations, it is necessary to choose forms and dimensions for the latter which differ greatly from those employed in land and ship stations, particularly as regards the structure of the aerials or antennæ, which for flying machines are necessarily of small size. In order to produce efficient radiation under such circumstances waves of small length must be employed, which waves are usually undesirable in ordinary radio-telegraphy owing to the disturbing effect of obstacles on the earth's surface, such as mountains or forests, these greatly reducing the effective range of reception. According to the present invention the short waves necessary for effecting transmission between land or ship and aerial stations are employed for the land or ship stations—hereinafter referred to as ground stations—intended to communicate with aerial stations, and the conditions found

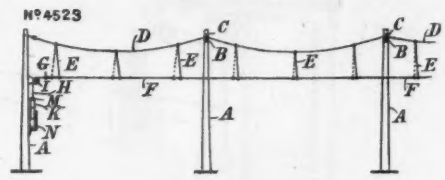



favourable in the latter stations are reproduced in the former by placing the whole of the antennæ structure of the ground station high above the surface of the ground or water, the dimensions of the structure being of the same order as those for the aerial stations. The antennæ $B^1$ $B^2$ and the transmitting and receiving apparatus C are carried by the mast A. The conductors or antennæ $B^1$ and $B^2$ are anchored to the ground by the wires D, the insulators E being interposed at the ends of the conductors and at any other point required. The high-frequency apparatus is operated from the cabin F at the ground level by mechanical or electrical distant control. Transmitting and receiving apparatus C, instead of being placed as shown in proximity to the antennæ, may be arranged in the cabin F, provision being then made for suitably transmitting the high-frequency oscillations between the antennæ $B^1$ and $B^2$ and the apparatus C. There is another illustration.—*April 22nd*, 1914.

### TRAMWAYS AND RAILWAYS.

4523. February 21st, 1914.—IMPROVEMENTS IN OR RELATING TO SUSPENSION AND TENSION ARRANGEMENTS FOR ELECTRIC TROLLEY WIRES OR CONTACT LINES, Siemens-Schuckertwerke G.m.b.H., of 3, Askanischer Platz, Berlin, S.W. 11.

This invention has reference to suspension and tension arrangements for electric trolley wires or contact lines, and is designed to provide improved means for preventing sagging by the application of weights or springs, in the case of trolley lines supported by catenary carrying wires and vertical suspenders or hangers. A A are the poles, on which arms or brackets B B with insulators C C are mounted. These insulators carry the supporting or catenary wire D, from which the trolley or contact wire F is suspended by means of the hangers E. H is a chain or the like, which is secured to the end of the trolley wire by means of insulators G, and extends over the wheel I, its lower end carrying the tension weight K or, it might be, having a connection to a tension spring. M and N are stops, which are provided if it be desired to limit the motion of the weight or spring, these stops being fixed to the adjacent pole A. When there is a fall in temperature the contracting trolley wire drags the lower ends of the hangers to the right, and raises the weight. This will continue until the latter comes against the upper stop M. Should the temperature therefore fall still further there will be no further movement, but the pull or tension on the trolley wire will be increased. On the other hand, if the temperature rises the trolley wire expands, the tension is relieved, and upon a continued rise in the temperature the weight K descends. The trolley wire at the same time moves the ends of the hangers to the left—it may be past the vertical position—until they

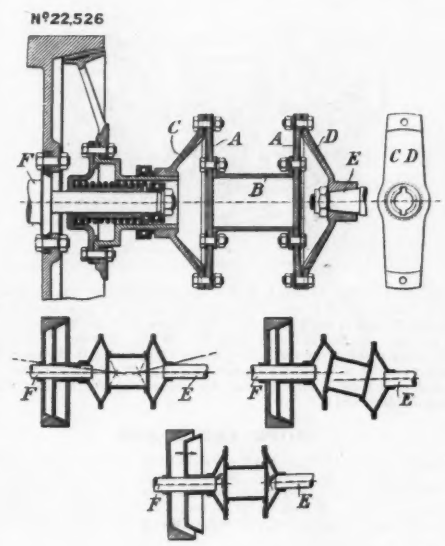



ultimately take up inclined positions towards the left as the weight comes against the lower stop N. Should the temperature still increase the tension in the trolley wire is further reduced and consequently there will be an increase in the sag. The increase in the tension of the trolley wire when the temperature is very low, and the increase of sag when there is a high temperature, can be kept without difficulty within reasonable limits, by adjustment of the stops, for instance, so that no danger to the proper working of the railway or tramway need be feared. —*April 22nd*, 1914.

### TRANSMISSION OF POWER.

22,526. October 6th, 1913.—SHAFT COUPLING, Société Anonyme des Automobiles Unic, 1, Quai National, Puteaux (Seine), France.

The oupling consists of two flexible dished discs A bolted to a central tubular member B and to arms C D on the clutch

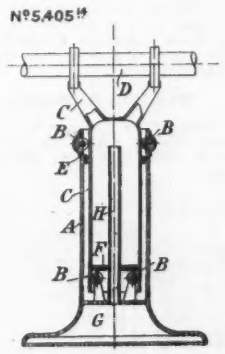



member and driven shaft respectively. As shown in the small views, the device permits of the driven and driving shafts E F being displaced relatively in an angular or parallel manner and also takes up the movement produced by moving the clutch out of gear.—*April 22nd*, 1914.

### MEASURING AND TESTING INSTRUMENTS.

5405 of 1914. Date of application January 13th, 1913.—MOUNTINGS FOR THE SUPPORT OF INSTRUMENTS ON BOARD SHIP, A. Barr and W. Stroud, Caxton-street, Anniesland, Glasgow.

This device is intended to prevent the vertical vibrations of a ship being transmitted to its range finders, telescopes, &c. It

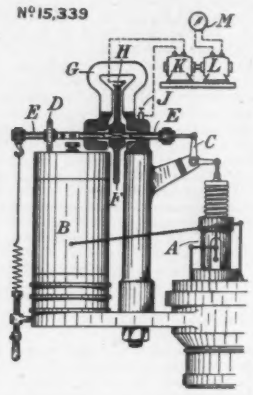



comprises a pedestal A provided with guide pulleys B for supporting an inverted vessel C carrying the instrument D. The pedestal is charged with water and air is pumped into the vessel C until the water level is at E F. An air reservoir G and a central pipe H may be provided within the pedestal to increase the volume of the supporting air cushion.—*April 22nd*, 1914.

15,339. July 3rd, 1913.—APPARATUS FOR INDICATING THE POWER OF ENGINES HAVING RECIPROCATING PISTONS, Pal Körösy, Bécsi-utca 4, Budapest, Hungary.

The basis of this invention is an ordinary integrating indicato comprising a pressure cylinder A, a drum B, transmitting mechanism C, and planimeter wheel D working on top of the drum Sliding on a squared portion of the shaft E is a wheel F which rotates between the poles of a magnet G. Alternating current is generated in the wheel F and is taken off at H J to a motor K

driving a generator L. The pointer of the voltmeter M is stated to take up a position corresponding to the mean speed of

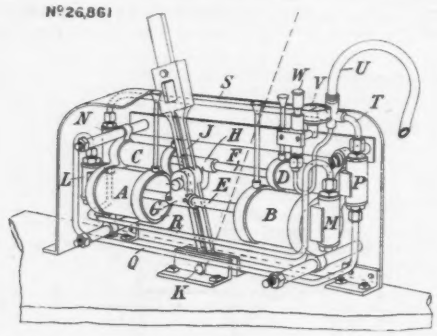



rotation of the shaft E; that is to say, to the mean power being developed by the prime mover.—*April 22nd*, 1914.

## PUMPING AND BLOWING MACHINERY.

26,861. November 22nd, 1913.—Two-stage Compression Pump for Air, Gas, &c., E. H. Hill and H. Hill, 56, Broomhall-street, Sheffield.

Two large-bore cylinders A B and two small-bore cylinders C D are mounted side by side on a common frame. The piston-rods E F are provided with crossheads G H, which are connected by pin and slot to an operating lever J pivoted at K. Combined

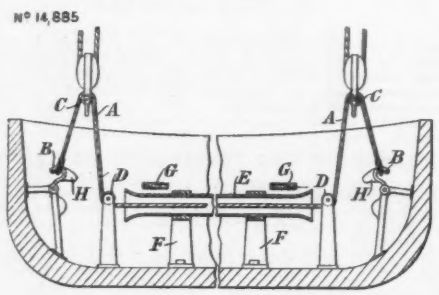



inlet and outlet valves L M N P are provided on the cylinders. The valve-boxes L and P are connected by a pipe Q and the boxes M and N by a pipe R. The boxes N P are connected by pipes S T to the delivery pipe U. While cylinder A is compressing and forcing air into cylinder D, cylinder B is on suction and cylinder C is delivering into the pipe S, and *vice versâ*. A pressure gauge V can be read by depressing the button W.—*April 22nd*, 1914.

## SHIPS AND BOATS.

14,885. June 27th, 1913.—Detaching Gear for Ships' Boats, P. M. Wotton, R.N.R., Avonmouth, Gloucester.

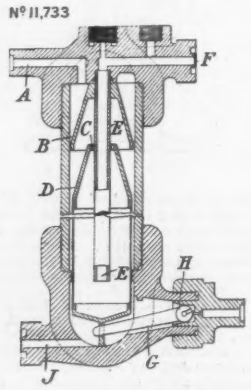
The boat is attached to the falls by means of a rope or chain A hooked at B B and passing round pulleys C C and D D. Between the pulleys D D it passes through a tube E mounted on brackets




F just beneath the thwarts G. The hooks B are weighted at H so that when the boat is afloat the chain or rope A is released automatically at one or both ends. If released at one end only the tension on the other end pulls the rope through the tube E.—*April 22nd*, 1914.

## MISCELLANEOUS.

,733. May 20th, 1913.—Apparatus for Separating Liquids from Elastic Fluids, B. Woollard, 48, Haftonroad, Catford, S.E., and Peter Brotherhood, Limited, Peterborough.



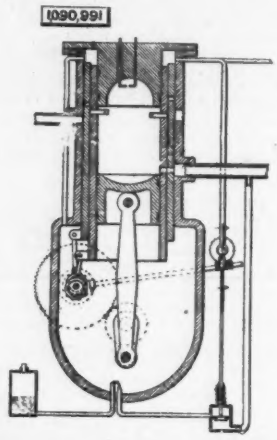

A particular application of this device is the separation from air after compression of the water introduced during the compression to reduce the heating effect. The air and water enter the separator at A and strike against the deflecting surface B. The water passes downwards to the foot of the separator and the air enters through holes C into the interior of a float D. Thence it passes up the pipe E to the outlet F. As the water collects the float D rises, lifts the lever G, and thereby operates the discharge valve H. A drain connection is provided at J.—*April 22nd*, 1914.

## SELECTED AMERICAN PATENTS.

*(From the United States Patent-office Official Gazette.)*

1,090,991. Internal Combustion Engine, *C. Y. Knight, Oak Park, Ill., assignor to Knight and Kilbourne Patents Company, Chicago, Ill., a Corporation of Delaware.—Filed June 4th*, 1906.

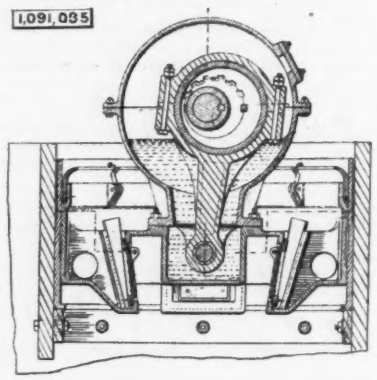
The engine has a main cylinder or casing, and a crank case on which this cylinder is mounted and into which it opens. Two telescoped sleeve valves control the ports of the engine and slide axially within the main cylinder. A working piston reciprocates in the inner of these sleeve valves. A head is fixed to the main cylinder and projects into the inner sleeve valve,




whereby a chamber is created at the ends of the sleeve valve removed from the crank case. The outer sleeve valve is in working relation to the main cylinder, and means are operatively connected with the piston for reciprocating the sleeve valves in the chamber whereby suction and compression is created therein alternately as the piston alternately creates suction and compression in the crank case. There are also means for supplying the crank case with lubricant in such a way that the lubricant will be caused to come in contact with the end faces of the sleeve valves and to be distributed between the valves lengthwise thereof. There are no less than forty-three claims.

1,091,035. Jigging Machine, *O. H. Bohm and W. M. McCoy, Birmingham, Ala.—Filed April 9th*, 1913.

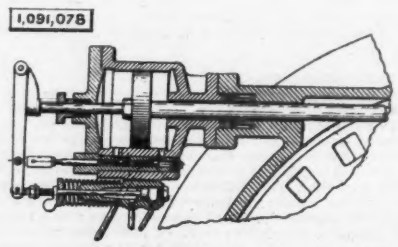
The machine is furnished with a cylinder, having a vertically reciprocatory plunger. There are overhead means for reciprocating the plunger comprising a drive shaft and an arm pivoted




to the plunger and excentrically connected to the shaft. An oil-containing casing encloses the arm and its connections to both shaft and plunger, and is movable with the latter. This movable casing has an opening to receive the shaft. There are fifteen claims.

1,091,078. Extracting Steam from Steam Turbines, *F. E. Norton, Lynn, Mass., assignor to General Electric Company, a Corporation of New York.—Filed January 11th*, 1913.

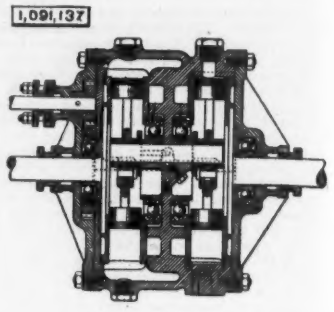
The inventor claims the combination with a multi-stage turbine, of a conduit for extracting steam from a stage of higher




pressure, an annular overflow valve between this stage and that next lower, a motor for opening and closing the valve, and means responsive to the steam pressure in the extraction stage for controlling the motor for the purpose of maintaining constant pressure in the stage. There are eight claims.

1,091,137. Hydraulic Transmission, *L. E. Hopkins, Cardiff, Wales.—Filed May 27th*, 1913.

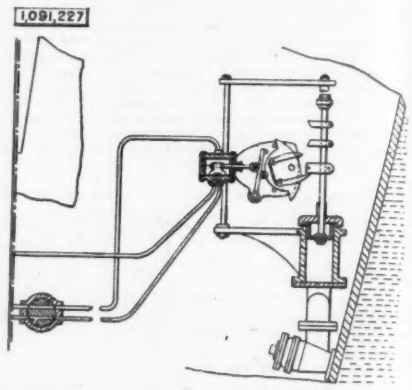
The machine comprises a rotor formed with a series of radially directed cylinders fitted with pistons, with means for connecting the pistons to the stator such that they may pursue an orbital path excentric to the axis of the rotor. There is an enclosing stator which provides an annular space around the rotor. A passage leads to this annular space, and another leads from it,




and there are partitions dividing this annular space into a number of compartments, and means are provided for displacing these partitions angularly relatively to the stator. There are five claims.

1,091,227. Means for Controlling the Supply of Motive Fluid to Marine Engines, *A. Kerr, Belfast, Ireland.—Filed June 21st*, 1913.

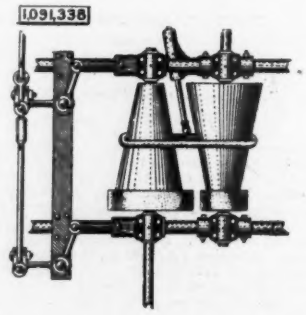
The device is provided with a supply of fluid under pressure, and also has a stop valve controlling lever, a cylinder with a piston working in it, and connected with the controlling lever. A valve controls the supply of pressure fluid to the cylinder. A second cylinder, with a piston in it, is connected to this valve, and a second valve controls the supply of pressure fluid to the second cylinder. There are means whereby the second valve is normally maintained at such a position that fluid under




pressure is cut off from the second cylinder. A pipe leads from a supply port of the second valve to the supply port into the second cylinder, and a pipe leads from a second supply port of the second valve direct to the casing of the first valve. A cock is interposed in the pipe lines and normally leaves them connecting the valves and cylinder as above stated, but have ports in them which are capable of being turned so as to place the two pipe lines in communication with each other, and by cutting off the connection with the second valve to place the pressure fluid in direct communication with the second cylinder, without passing through the second valve. There are nine claims.

1,091,338. Transmission and Reversing Gearing for Engines, *L. J. Houpt, Blencoe, Iowa.—Filed February 26th*, 1913.

The device has a pair of parallel supporting shafts, and a pair of bearings rigidly secured to these shafts in alignment with one another. A driving shaft is rotatably mounted in these bearings, and an additional pair of bearings is slidably mounted on the shafts. A driven shaft is rotatably mounted in the last-mentioned bearings. Oppositely disposed cone pulleys are carried on the driving and driven shafts between the pairs of bearings.

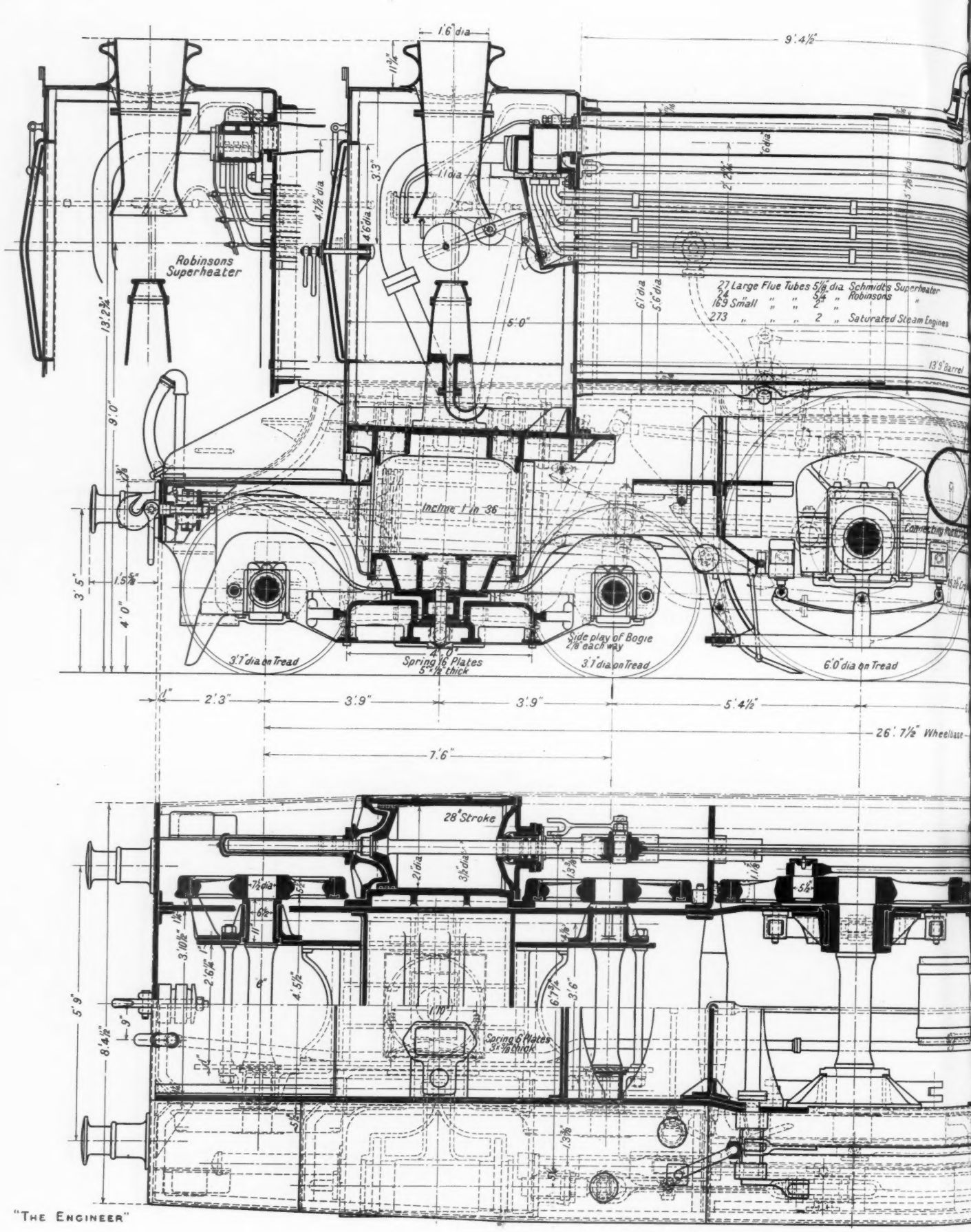



There are means in connection with the sliding bearings for moving the same on the supporting shafts to remove correspondingly the one pulley laterally with respect to the other. There are friction clutches on each of the pulleys adapted for engagement with one another to cause one pulley to be rotated upon the rotation of the other. An endless flexible connection is disposed over the pulleys to cause one of the latter to be rotated upon the rotation of the other when they are spaced from one another, and there are means for moving the endless connection longitudinally on the pulleys. There are two claims.

Contracts.—The Hydraulic Engineering Company, Limited, Chester, has obtained the order for the hydraulic sluice and dock gate machinery required by the North-Eastern Railway Company for its new north entrances to the docks at West Hartlepool. The gate machinery will be constructed in accordance with Norfolk's patent, and will be similar to that which has been supplied by the Hydraulic Engineering Company, Limited, for the entrance and graving dock gates for Hull Joint Dock.

# LONDON AND SOUTH-WESTERN R[AY]

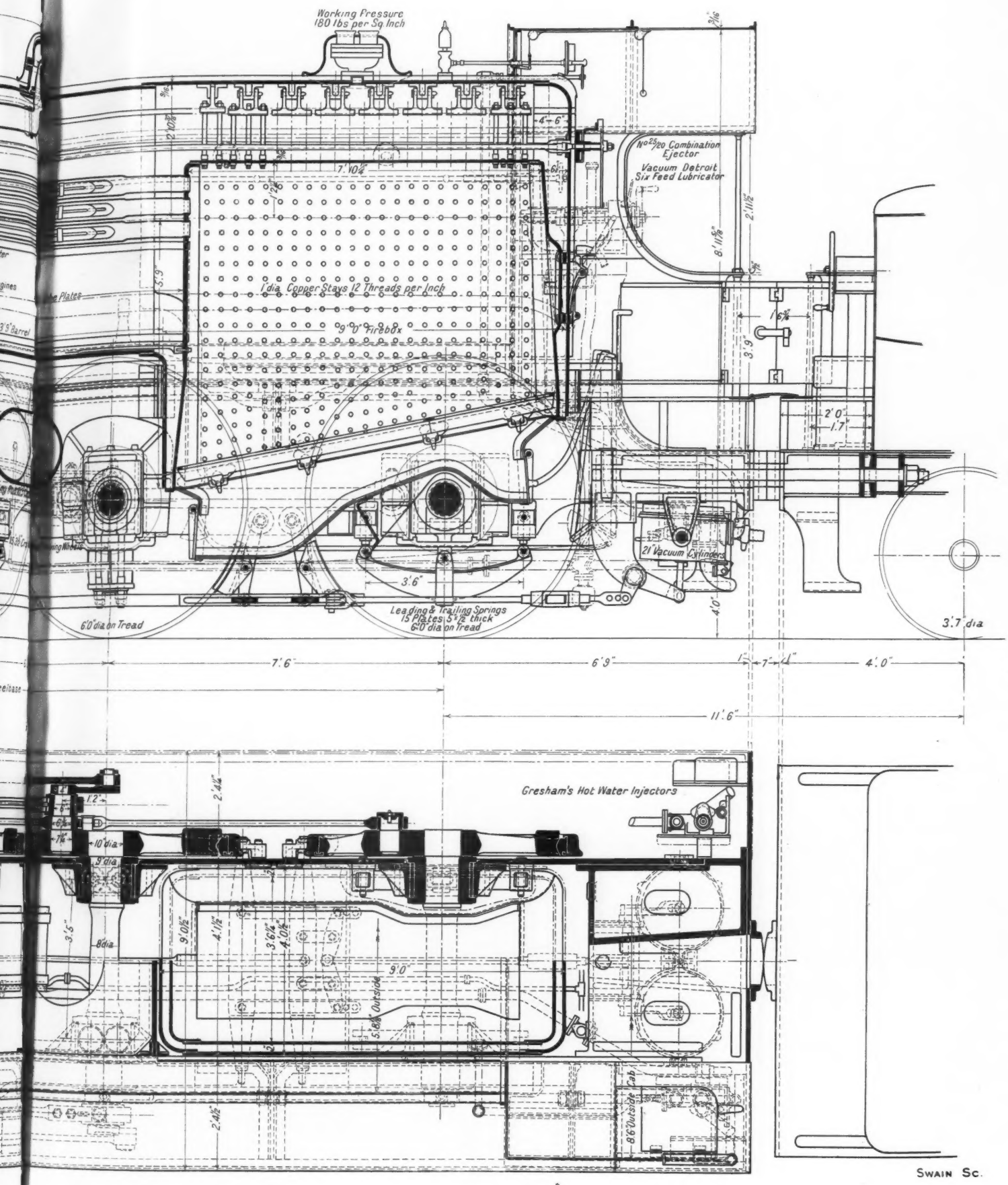
MR. R. W. U[RQUH]GH,




"THE ENGINEER"

# N R[illegible]AY–MIXED TRAFFIC LOCOMOTIVE

W. U[illegible]GH, ENGINEER



## A NEW ELECTRIC RAILWAY IN THE UPPER RHINE DISTRICT.

THERE has recently been put into operation in the Upper Rhine a new electric railway extending from Belfort to Réchésy, which is proving a great boon, for prior to its completion the Belfort district was only served by main lines, as shown in the map, Fig. 1. From the Paris to Mulhouse main line (Eastern Railway system), which crosses the electric lines from north-west to east, branch off the lines from Belfort to Delle (continuing towards Basle by Délémont) and the lines from Belfort to Giromagny. The P.L.M. system also penetrates the district with the lines from Besançon to Belfort and from Montbéliard

Fig. 1—MAP OF LINES IN BELFORT DISTRICT

to Morvillars, which serve the southern cantons. But, in spite of these connections, some of the cantons were badly served. In the north-east the industrial district of Rougemont le Château, adjacent to the Vosges, was in need of a rapid railway system; likewise on the south-west the rich valley of La Savoureuse near the industrial district, Montbéliard, and on the south-east the agricultural district bordering the German frontier. It was therefore decided to construct a local railway which would put these districts into direct and rapid connection with the main lines. The scheme was decided upon in 1906, but owing to there being some difficulty in the way of settling the course of the line and choice of system, the work was not commenced until some time afterwards. Ultimately plans were prepared for the construction of an electric railway comprising the following lines:—

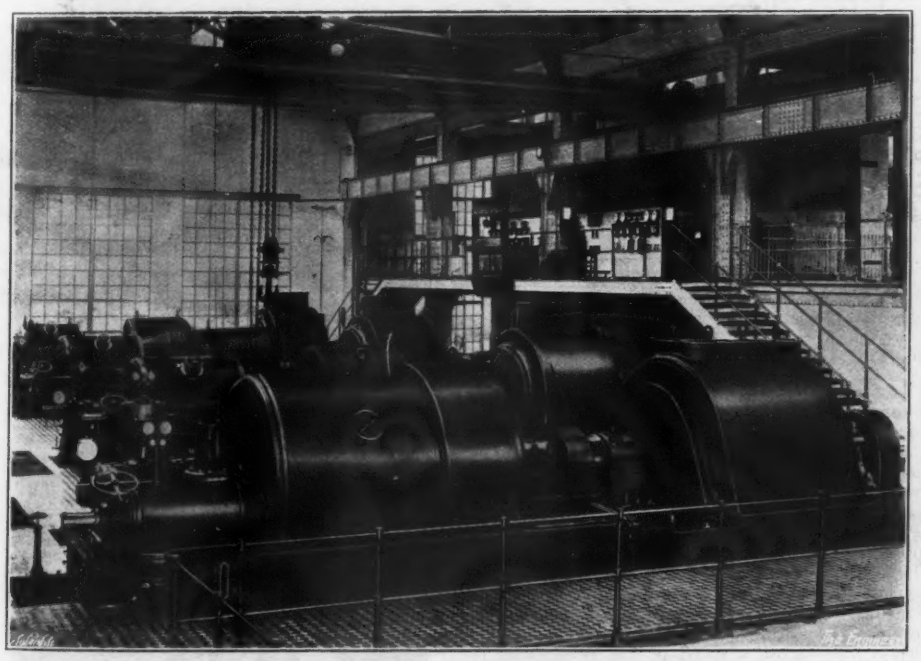


Fig. 2—THE POWER STATION AT RONCHAMP

Belfort to Sochaux, 16.35 kiloms.; Belfort to Réchésy, 28.925 kiloms.; and Belfort to Rougemont, 15.19 kiloms. Connected with the last line are branch lines from Errues to Etueffont (5.8 kiloms.), and from Errues to La Chapelle (5.14 kiloms.). The system in the neighbourhood of Belfort is about 70 m. long; the gauge is 1 m. Gradients are slight, but there are numerous curves of small radius. The minimum radius was fixed at 50 m., but this had to be reduced to 40 m. in certain cases. With steam trains these curves would have necessitated a slow service, but the rapid acceleration obtainable with electric traction compensates for the loss of time that occurs at curves. Owing to the length of the railway, the maximum load of the railway does not reach 1000 kilowatts, it was not considered advisable, if it could be helped, to build a power-house solely for the purpose of supplying current to the new line. At about 20 kiloms. from Belfort is a power station belonging to the Société Des Houillères de Ronchamp, which contains three turbines of 2500 horse-power and one of 5000 horse-power. This station—see Fig. 2—is worked on economical lines, the fuel used being a mixture of good coal and mine slack. Three phase current is generated at a pressure of 5000 volts, and it is transmitted by four 30,000-volt lines to Belfort. From sub-stations at Remiremont, Giromagny, and Servance current is supplied at 5000 volts the ordinary low-voltage direct-current system could not be used, nor did a 1200-volt direct-current scheme offer the best advantages. After careful consideration the engineers decided upon the single-phase system, working at a pressure of 6600 volts, but at first it was thought inadvisable to use this voltage in the town of Belfort, and the plan of lowering the pressure on this portion of the railways was put forward. It was recognised, however, that a uniform pressure all over the system would be far preferable. Special attention was therefore paid to the design of

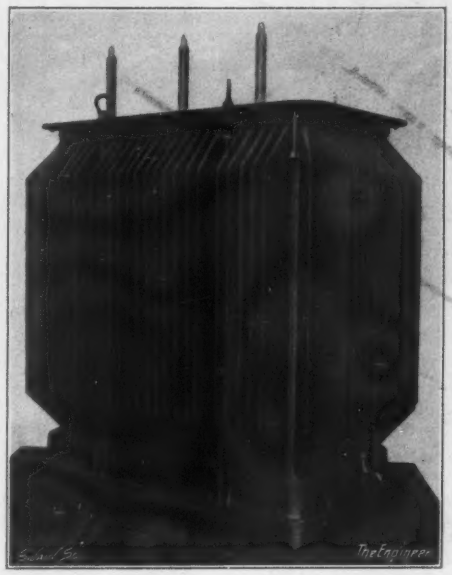


Fig. 3—TRANSFORMER

the overhead equipment, and by avoiding all danger in the event of an overhead wire breaking permission was obtained to use 6600 volts in Belfort. The principal contractors for the railway were Baert and Verney, of Mans, who sub-let the work associated with the overhead lines to MM. Bisson, Bergès et Cie., and the remainder of the electrical portion to the Société Alsacienne de Constructions Mécaniques, of Belfort.

No waterfalls were to be found anywhere near the railway, and therefore it became necessary to obtain the requisite power from some other source. As to large consumers, who transform it down to suit their requirements; current is also sent out from these sub-stations at 240 volts, and at this pressure small consumers are supplied. As said already, the Ronchamp station is operated on economical lines; this is not only due to the kind of fuel used, but also to the fact that it has a very good load factor, and, consequently, it became possible to supply current to the railway at low rate. The normal power required by a 50-ton train when travelling at a speed of 30 kiloms. per hour is about 50 horse-power; when on a gradient of 4 per cent. and travelling at a speed of 18 kiloms. per hour it requires 160 horse-power. If, then, the average be taken at 75 horse-power, and four trains are running at the same time—the time table does not provide for more—the total demand is

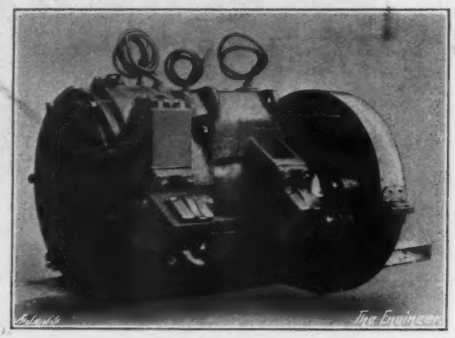


Fig. 4—SINGLE-PHASE MOTOR

300 horse-power, or, allowing for losses in motors and transformers, and fixing the efficiency at 75 per cent., 300 kilowatts. With a .75 power factor and a line efficiency of .9 the apparent power becomes

$$\frac{300}{.75 \times .9} = 445 \text{ kilovolt-ampères.}$$

A sub-station—see Fig. 15, p. 568—with a capacity of 500 kilowatts has been built at the depôt of La Forge, near Belfort, and it is supplied with three-phase 30,000-volt 25-cycle current from the generating station at Ronchamp. After the current passes the usual protective apparatus, it is transformed down in transformers—see Fig. 3—to 3000 volts. Converters then change the three-phase current into single-phase current and supply it to the overhead wires at 6600 volts and 25 cycles. Each converter consists of a three-phase asynchronous motor and a synchronous single-phase generator coupled together, as shown in Fig. 15. A third set having a capacity double that of the existing sets is to be added at some future time, and this new converter is to supply current to new electrified lines. Each existing asynchronous motor develops 550 horse-power, runs at 485 revolutions per minute, with 3300-volt 25-cycle current. At full load the generators have an efficiency of 93 per cent. and a power factor of .88. Each synchronous generator, coupled to its asynchronous motor,

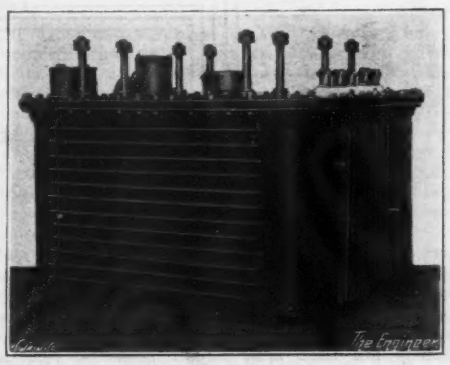


Fig. 5—MOTOR COACH TRANSFORMER

is designed to develop 450 kilovolt-ampères, or 360 kilowatts at .85 power factor, and it gives 68 ampères at 6600 volts. A Thury regulator controls the exciting current of each generator automatically, and a practically constant voltage is thus secured.

Each oil-cooled transformer is rated at 500 kilovolt-ampères, and supplies independently current to one of the converters. A third transformer serves as a spare. The primary and secondary windings are in each case star connected, and the former are fed with current at 30,000 volts, whilst the latter supply current to the converters at 3000 volts.

It can be seen from the illustration of the sub-station, Fig. 16, that these transformers are placed on the floor level in a position where plenty of cool air from outside can circulate around the cases, and the arrangement is said to have had the effect of keeping the transformers very cool; the temperature does not exceed 50 deg. above that of the surrounding air. All the high-tension switches have been placed in masonry cells. Those dealing with the 3000-volt current are above the transformers, whilst the 6000-

volt switches are behind a marble panel. It can be seen from Fig. 16 that the 30,000-volt switching equipment is mounted on a platform; the bus-bars are connected to four transformers, two of which, as explained above, lower the pressure to 3000 volts for the motors of the converters. The other two transformers have a ratio of 3000/110, and supply current for lighting the sub-station and for operating the trip coils of the high pressure switches. From the generator side of the converters the single-phase current is conveyed by cables to the 6600-volt switches, which are of the remote controlled type. On the generator sides of the motor converters the maximum-current circuit breakers are fitted with time limit devices, so that the current is only cut off in the event of a persistent short circuit. There are only two feeders; they are connected to two sections of the overhead wires near the sub-station, and in circuit with these feeders are time limit circuit breakers, lightning arresters, and low-voltage switches. The usual instruments are fitted to the 6600-volt switch panels.

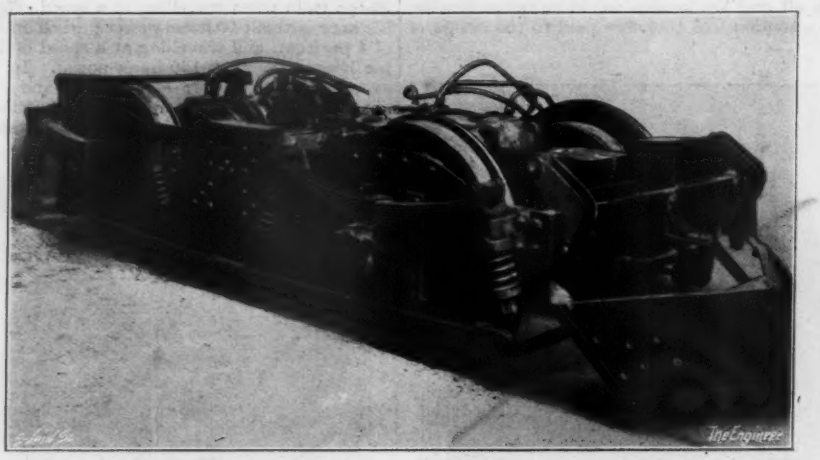


Fig. 6—MOTOR TRUCK

The motor coaches—see Figs. 13 and 14—have two motor bogies, as shown in Fig. 6, each of which is fitted with two 35 horse-power motors—Fig. 4. The mechanical part was built by the Société de Constructions du Nord de la France and Nicaise and Delcuve, of Blanc-Misseron (Nord). The electrical part was made by the Société Alsacienne de Constructions Mécaniques, of Belfort. Each motor coach has, in addition to the four motors, a main transformer—Fig. 5—and the necessary equipment for multiple-unit control, an air compressor for the brakes, and the usual arrangements for lighting and heating. Fig. 7 gives a complete diagram of connections. The motors—see Fig. 8—are compensated repulsion machines. There are therefore two stator windings, a main exciting winding, and a compensating winding. The builders of the electrical equipment appear to favour this type of motor, because a fairly high voltage can be applied to the stator, and the working current is therefore small in comparison with that of a series motor. Furthermore, the makers contend that the commutation of these motors is every bit as good as that of a continuous-current motor. Speed variation is effected by varying the voltage at the terminals of the motor. The following pressures are applied:—310, 415, 500, and 550 volts. The motors, which are well ventilated, are designed to develop from 35 to 40 horse-power for one hour with a temperature rise not exceeding 75 deg. above the surrounding air. The gear ratio is 1—4.93, and when the armature is running at a speed of 750 revolutions per minute the speed of the coaches is 24.4 kiloms. per hour. The diameter of the driving wheels is .85 m. It is possible to run the motors at 1400 revolutions per minute, and the speed of the coaches is then 45.5 kiloms. per hour. Some of the motor coaches are making daily a journey of more than 220 kiloms. without undue heating of the motors. Characteristic curves showing the performance of the motors are given in Fig. 9.

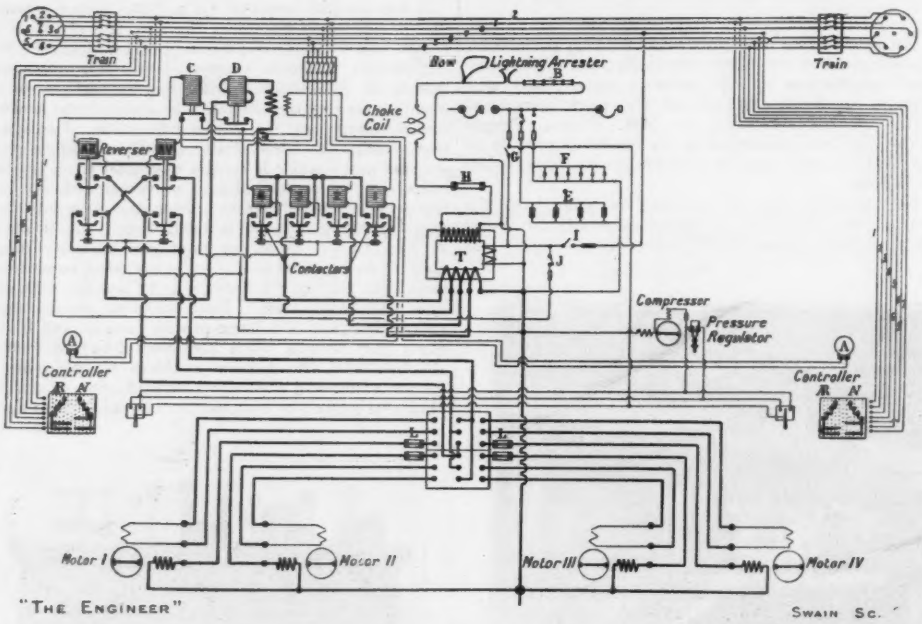



Fig. 7—MOTOR COACH CONNECTIONS

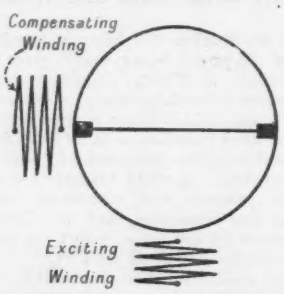



Fig. 8—WINDINGS OF SINGLE-PHASE MOTOR

The transformer on each motor coach is suspended under the coach between the two bogies. The windings are immersed in oil. There are two secondary windings. One is wound to give 120 volts for lighting and heating, for working the compressor motor and for operating the contactors; the other winding supplies the main driving motors. It has five tappings, permitting the application to the motors of the four above-mentioned voltages, thus giving four speeds. Tests have shown that the efficiency of the transformers is 97.2 per cent. Although a single motor coach will develop sufficient power for a complete train such as is used under ordinary conditions on the Belfort system, it was, nevertheless, thought advisable to equip the motor coaches for multiple-unit control, so that, if necessary, trains can be made up with more than one motor coach. The control system adopted by the Société Alsacienne de Constructions Mécaniques only permits one contactor to be closed at once. The control system—see Fig. 7—comprises two controllers, one reverser, four contactors, and a special protective arrangement. The controllers only deal with the small currents that are needed for energising the bobbins of the contactors, and their dimensions are small. A simple arrangement automatically puts all the contactors to the off position as soon as the driver releases the controller handle. The contactors are fitted with powerful magnetic blow-out coils, and the control system is designed so that it is impossible to short-circuit a section of the transformer. Reversing is effected by two contactors with two sets of contacts, as shown in the diagram. The operation of one or the other of these contactors makes the connections for forward or backward running. It is impossible for both contactors to close at the same time. Overloads and short circuits are dealt with by the circuit-breaking apparatus C and D. Coil D is in series with the motors, and when a heavy current passes through it a solenoid short-circuits two contacts, and in this way energises the fine wire winding of coil C.

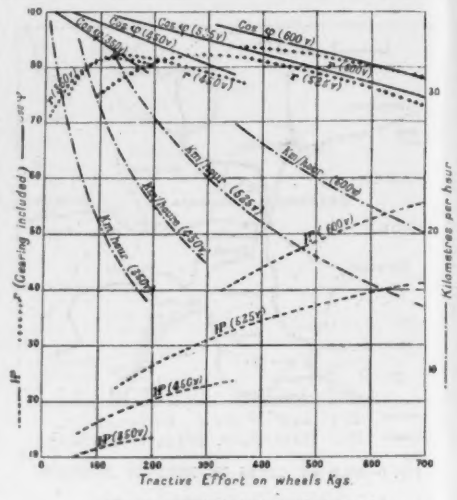



Fig. 9—PERFORMANCE CURVES

This coil de-energises the contactor coils, and the latter break the motor circuit. The circuit is always broken by the contactors.

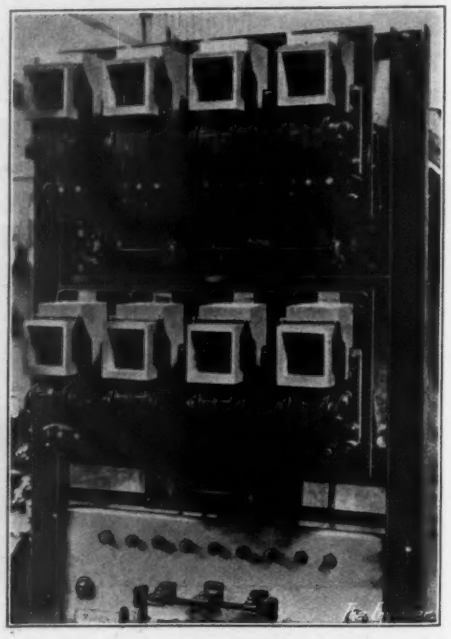


Fig. 10—CONTACTOR PANEL

In the 6600-volt circuit there is the usual protective apparatus, comprising a horn lightning arrester, inductive resistance, and a fuse. All high-tension apparatus is placed in a chamber at the centre of the car. Arrangements are made for earthing the high-tension parts automatically when the door of the chamber is opened. The medium-voltage equipment, such as contactors—see Fig. 10—contactors, isolating switches for the motors, and the switches which de-energise the contactors in the event of an overload, are mounted on a marble panel and enclosed in a cupboard. One terminal of all the circuits is

## ELECTRIC MOTOR COACHES—UPPER RHINE DISTRICT

Fig. 11—ELECTRICALLY-CONTROLLED AIR COMPRESSOR

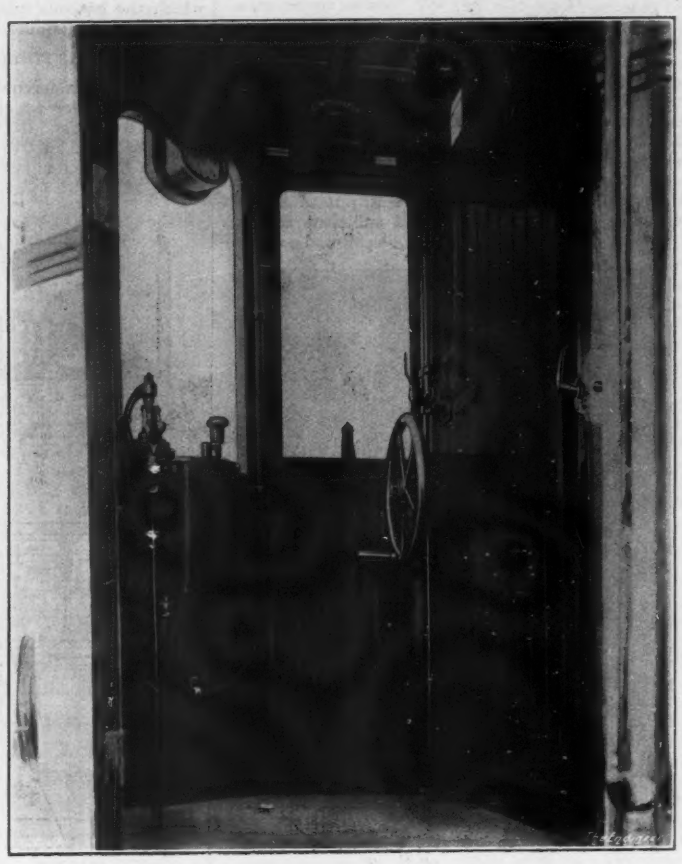


Fig. 12—DRIVER'S CAB

earthed; the roofs of the coaches are likewise earthed. The multiple-control cable is composed of six conductors, which are connected to couplings at each end of the cars. Bows operated by compressed air collect the current from the high-tension wire; one bow is used for one direction of running, and the other for the reverse direction. By turning a two-way cock compressed air is admitted to one cylinder and released from the other cylinder; the bow connected to the first cylinder is thus raised, whilst the bow connected to the other cylinder is lowered. By means of another lever it is possible to let the air out of both cylinders at once, and then both bows are lowered away from the overhead wire. A 3.5 horse-power single-phase repulsion motor drives the compressor which supplies compressed air to the bows and brakes. The compressor, which is enclosed in a cupboard—see Fig. 11—delivers 11 cu. ft. of air per minute at a maximum pressure of 100 lb. per sq. in. An automatic regulator starts and stops the compressor in the usual way. The motor works at 110 volts, runs at 900 revolutions per minute, and drives the compressor through reduction gearing having a ratio of 5 to 1. A view of one of the driver's compartments is given in Fig. 12.

The overhead equipment, as explained at the beginning, was constructed by Bisson, Bergès et Cie., and, as may be seen from Fig. 14, it is of the single catenary type. The copper conductor has a sectional area of 50 square millimetres, and the carrying cable is a steel-stranded cable. Chain droppers spaced about 3 m. apart serve for suspending the copper wire. Clips at the ends of the droppers join the latter to the catenary cable and contact wire. Oil switches are provided for dividing the line into sections in the ordinary way. In Belfort steel poles have been erected, but those on the remainder of the railway are of reinforced concrete, and tapered as shown in Fig. 12. The arrangement of insulators, &c., can also be understood from this illustration.

The line has now been in operation over eight months, and by reason of the rapid development of traffic four new motor coaches have been ordered.

## THE BONECOURT SURFACE COMBUSTION PROCESS.

No. II.*

METAL MELTING.

Considerable economy of time and gas consumption is shown as the result of careful tests which have been made of metal melting in a tilting furnace fired with coal gas on surface combustion lines. The crucible used was the 110 lb. size, and the following are the consumptions of coal gas found to be required per pound of metal melted in the case of the three metals tried:—

| | Gas consumption per pound of metal melted. | Time required for melting. |
|---|---|---|
| Brass | 1.7 cubic feet | 25 min. |
| Copper | 3.1 cubic feet | 30 min. |
| Aluminium | 3.4 cubic feet | 25 min. |

It will be noticed that, although the melting point of aluminium is considerably below that of copper, the gas consumption per pound of metal is higher in the case of aluminium. This is attributable to the higher specific heat and latent heat of fusion of the metal.

The combustion of the gaseous mixture around the crucible is not found to affect adversely the life of the crucible. The combustion products contain little or no free oxygen, and the plumbago of the crucible is not therefore rapidly burned away. After a run of thirty melts in one crucible, for example, the crucible was found to be still in very good condition and available for a considerable number of further melts.

So far we have dealt with the industrial application of surface combustion in this country. In America the technical direction of the development of the process

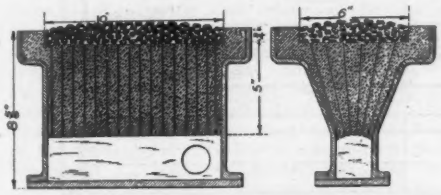



Fig. 6—PROFESSOR LUCKE'S SYSTEM

is in the hands of Professor Lucke, of Columbia University, New York. Arrangements have been made between the English and American organisations for the mutual exchange of ideas in this field. Professor Lucke has devoted much attention to the details of construction of what might be described as unit combustion elements capable of assemblage for the purpose of providing an incandescent granular bed of any desired extent and readily applicable to a wide range of existing apparatus. The principle adopted is shown in section in Fig. 6, the arrangement comprising an iron casing carrying a fire-clay body which is pierced with a multitude of fine perforations through which the gaseous mixture passes from the back of the casing into the bed of granules. Professor Lucke has shown in the exhaustive paper which he contributed to the American Chemical Society in October, 1913, that these units can be put together so as to yield an assemblage in which 20,000 cubic feet of town's gas can be burnt per hour over a total area which is only 3 feet square.

STEAM GENERATION.

Coming now to the question of steam generation by means of surface combustion, it will be recalled that there were published some two or three years ago for the first time the results of the trial of a small boiler which had been installed in Leeds for firing with coal gas. This boiler was made purely by way of experiment, but some particularly striking performances were obtained with it. An efficiency of 94 per cent. when steaming at the high rate of 20 lb of water evaporated from and at 212 deg. Fah. per square foot of heating surface per hour was claimed, and these claims aroused sufficient interest to induce several influential manufacturing concerns abroad to send representatives to this country with a view to examining the truth of these statements. Among others the Berlin Anhaltische Maschinenbau Actien Gesellschaft sent a deputation, which included well-known German boiler engineers and experts, to make exhaustive tests of the boiler in question. The official report presented by the deputation on its return to Berlin stated that the efficiency of the boiler was 93.8 per cent. when fired with coal gas, and evaporating water at the rate of 35.2 lb. per square foot per hour from and at 212 deg. Fah., the steam pressure in the boiler being 114 lb. per square inch. These results sufficed to prove the attractiveness of the underlying principles, and induced the firm in question to enter into reciprocal arrangements with Bonecourt Surface Combustion, Limited, for the further development of the system generally and for the application of surface combustion to industrial processes in Germany and certain other continental countries.

Since that time experiments have been made with various forms of industrial gaseous fuels and with various sizes and constructions of boiler tubes. The general principle adopted is the same as that described above in the case of furnaces. The tubes of the boiler are furnished with a refractory packing, which serves to determine and accelerate the combustion, and which at the same time plays a very important part in effecting the rapid transmission of heat from the zone of combustion to the water surrounding the tubes. This heat transmission takes place partly by way of radiation from the incandescent granules, and partly by reason of the baffling effect which the granules exercise on the swiftly flowing gases. The gaseous mixture is supplied to the refractory packing in the tubes through apertures of relatively small bore disposed in fire-clay plugs situated in the entrance ends of the tubes. In order to cause the gaseous mixture to pass through these apertures at the speed requisite to prevent back ignition, it is necessary to maintain a certain pressure difference between the entrance and exit ends of the boiler tubes. This pressure difference in normal cases lies between 10in. and 30in. water gauge, and may be produced either by supplying the gas and air to the boiler under a positive pressure, or by withdrawing the products of combustion from the exit end of the boiler by means of a suction fan. In the latter case the gaseous fuel is supplied at the entrance of the apertures in

* No. I. appeared May 15th.

the fire-clay plugs in such manner that the atmospheric air drawn through the apertures under the action of the suction carries with it and thoroughly mixes with the gaseous fuel.

BOILER FIRED WITH ILLUMINATING GAS.

These underlying principles of operation will be made clearer by reference to Fig. 7, reproduced from a photograph of a boiler which has recently been installed in London for the purpose of operating a steam hammer. The boiler is 8ft. long by 3ft. 6in. in diameter, and is fitted with five tubes each of 6in. bore. It is fired with coal gas from the town main, and is capable of a maximum steam output of 2000 lb. per hour. Normally it is found sufficient to work

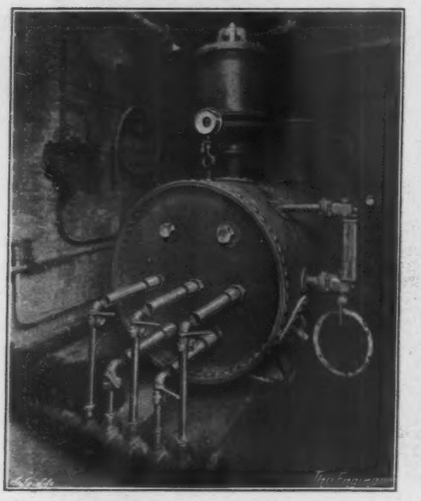


Fig. 7—BOILER FIRED ON THE BONECOURT SYSTEM

the boiler for the purpose of operating the steam hammer at about half this output. This particular boiler furnishes an instance of a case where it is a feasible proposition to employ the expensive illuminating gas of London for steam making. The justification for the use of so expensive a form of fuel lies in the adaptability of the boiler and the ready way in which it can be made to yield its steam as required for the operation of the hammer, and, further, in the fact that the erection of a chimney was dispensed with, which would have been particularly expensive in this instance. The London County Council insisted on a tall chimney being erected on hearing that a boiler was going to be put down, but waived the point as soon as it heard that a Bonecourt boiler was proposed, giving as its reason that it was satisfied that no poisonous products of incomplete combustion—*e.g.*, carbon monoxide—were evolved. With regard to adaptability, each time the hammer is wanted the boiler is fired, and the gas immediately turned off as soon as the work of the hammer is finished.

In this particular boiler a novel type of construction has been employed with regard to the boiler tubes. The formation is shown in Fig. 8. The tubes at their entrance ends are narrowed down somewhat into the form of a bottle neck. The narrow part of the tube serves for the introduction of the gaseous mixture at the required high speed to prevent back ignition, while the rest of the tube is charged with the refractory material. By this means the use of fire-clay plugs in the entrance of the boiler tubes is dispensed with, and the necks of the tubes, through which the gaseous mixture passes, are kept cool by the surrounding boiler water

COKE-OVEN GAS-FIRED BOILER.

In passing, reference might be made to the first Bonecourt boiler which was erected at the Skinningrove Ironworks. It was fired with coke-oven gas and evaporated 5000 lb. of water per hour. Exhaustive tests of this boiler were made some eighteen months ago, and reported in the technical Press. The thermal efficiency of the boiler was 92.7 per cent. when producing steam at the rate of 5000 lb. per hour and at a pressure of 100 lb. per square inch. The boiler was 10ft. in diameter and 4ft. long, was furnished with 110 tubes each of 3in. bore, and possessed a total heating surface of 316 square feet. The evaporation therefore amounted to 15.8 lb. of water from and at 212 deg. Fah. per square foot of heating surface per hour, and would have amounted to 20 lb. per square foot without detracting from the efficiency had the boiler been made only 3ft. long instead of 4ft. The extra length was employed simply for the purpose of providing increased water and steam space.

The manner in which the tubes are fired is substantially the same as that described above in the case of the boiler fired with town's gas. In both cases the necessary pressure difference is provided by means of a single fan situated at the exhaust end of the plant, the suction sufficing to draw the gas through the boiler tubes from gas cocks situated at the entrance ends of the tubes, and at the same time to draw in with the gas the necessary air from the atmosphere. The gas and air before gaining admission to the refractory packing in the boiler tubes pass through short tubes projecting from the boiler face, serving to mix the constituents thoroughly before reaching the combustion zone. The air admitted to the tubes is regulated by means of a damper situated between the boiler and the fan, the correct proportioning of gas to air being obtained by regulation of the gas supply. From the front of the boiler a clear view is obtained through all the mixing tubes, the glow produced in the combustion zones being clearly seen. A boiler of this type under fire is a very pretty sight. No flame is visible, only a number of bull's eyes of incandescence being seen, all glowing with equal brilliancy. As the gas supply is increased or decreased the intensity of the glow changes, the maximum brilliance being obtained when the gas and air passing through the tubes are precisely in the proportions which theory demands. Excess of air or excess of gas reduces the glow, thus furnishing a very simple and excellent criterion for the proper proportioning of the supplies.

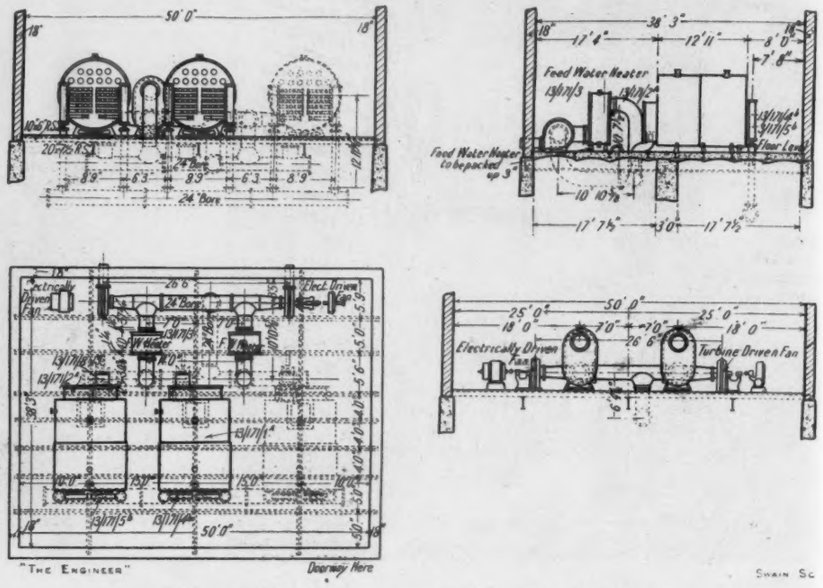



Fig. 9—BOILERS FIRED WITH AMMONIA RECOVERY PRODUCER GAS

With regard to the satisfactoriness of the boiler from a practical point of view, it is of interest to note that the Skinningrove Company has ordered a duplication of the plant, and the second unit will be in operation in a few weeks. It is further of interest, from the point of view of confirming the claims which are made for this boiler with regard to efficiency and steaming power, that a precisely similar plant has been ordered by Messrs. Friedrich Krupp for their works at Essen. The boiler has been installed and tested, and substantially the same results have been obtained.

TUBE DIMENSIONS.

The first tubes to be employed in the construction of Bonecourt boilers were 3in. in bore and from 3ft. to 4ft. in length. The present tendency is to employ tubes of greater bore, one advantage being the increased steaming capacity which it is possible to obtain from a single boiler unit. In consequence of the greater cross-section of the combustion zone thereby occasioned, some difficulty was at first experienced in the provision of refractories capable of withstanding indefinitely the temperatures produced with gases of high calorific intensity, such as coke-oven gas. This difficulty has been overcome by employing instead of refractory fragments disposed in the tubes in a haphazard manner, granules of such size and shape as to stretch entirely across the diameter of the tube. By arranging these granules in a staggered manner down the length of the tube the surfaces of the granules radiate heat freely to the surrounding tube walls, and the temperature of the granules does not much exceed 1000 deg. Cent.

FAN POWER CONSUMED BY BONECOURT BOILERS.

It will be observed that the use of surface combustion in the generation of steam necessitates the application of a considerable pressure difference to overcome the resistance to gaseous flow exercised by the refractory packing in the boiler tubes. This does not necessarily mean that a large consumption of power is involved. The actual percentage of power consumed will depend on the quality of the fan equipment, but with the excellent blowing and exhausting appliances obtainable to-day it is possible to make out a good case for the employment of even much higher pressure differences than those hitherto employed in the Bonecourt system, at all events, in special cases where compactness of plant is of first importance.

As an example of standard practice, however, we might take the power required for driving the fan in the case of the Bonecourt boiler installed in Messrs.

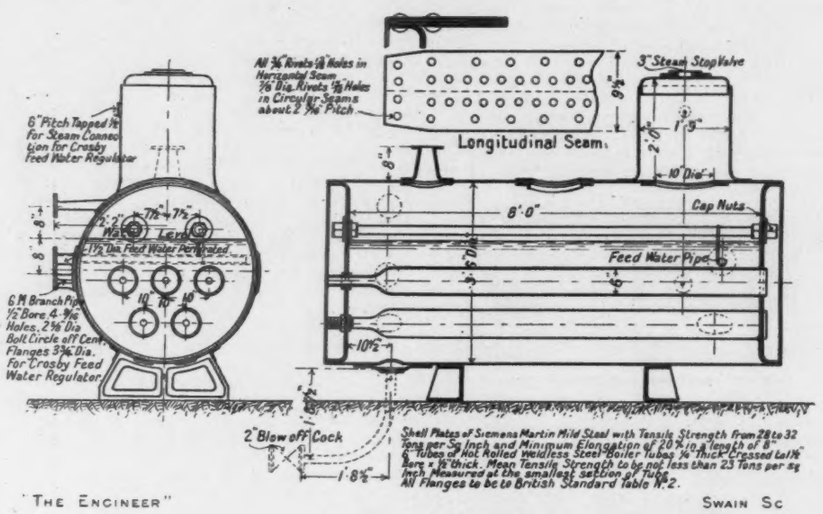

All ¾" Rivets ⅞" Holes in Horizontal Seam, ⅞" Dia. Rivets 1⅛" Holes in Circular Seams about 2 ¾" Pitch
3" Steam Stop Valve
Longitudinal Seam
6" Pitch Tapped Hole for Steam Connection for Crosby Feed Water Regulator
Cap Nuts
Feed Water Pipe
6'0"
10" Dia.
6 M Branch Pipe ½" Bore, 4-⅜" Holes, 2⅝" Dia Bolt Circle off Centre Flanges 3¾" Dia. For Crosby Feed Water Regulator
2" Blow off Cock
Shell Plates of Siemens Martin Mild Steel with Tensile Strength from 28 to 32 Tons per Sq. Inch and Minimum Elongation of 20% on a length of 8" 6 Tubes of Hot Rolled Weldless Steel Boiler Tubes ¼" Thick Grossed Let ⅛" Bore × ⅛" thick. Mean Tensile Strength to be not less than 23 Tons per Sq. Inch. Measured at the smallest section of Tube. All Flanges to be to British Standard Table No. 2.
"THE ENGINEER"
SWAIN SC

Fig. 8—SECTIONS OF BOILER

Krupp's works. The combustion products delivered from the fan amount to 130,000 cubic feet per hour, and have a specific gravity of 0.89. The theoretical air horse-power with this volume of products at a suction of 17.1in. water gauge amounts to 4.1 horse-power, so that a direct coupled fan designed for this load with a fan efficiency of 55 per cent. would require 7.5 horse-power. Actually in practice 16.1 horse-power was measured, as the motor driving the fan was 27 horse-power instead of 7.5 horse-power, and the fan, which was much too large and therefore under-run, was belt-driven instead of being directly coupled to the motor.

Taking the power required by the fan, therefore, as 7.5 horse-power, and allowing 22 lb. of steam per horse-power hour, the percentage of the boiler power absorbed in driving the fan is 3.87 per cent., while if 15 lb. of steam be taken as the equivalent of one horse-power hour, the power absorbed in driving the fan amounts to only 2.7 per cent. of the power developed by the boiler. That a fan efficiency of 55 per cent. can be obtained is evidenced by the published tests of the De Laval Company, of Stockholm, which show that efficiencies of fans of the above-mentioned capacity exceeding 60 per cent. between half load and full load have been obtained. In fact, in one test employing a fan working under almost the identical conditions mentioned above, the actual horse-power consumed was only seven.

### BOILER INSTALLATION FIRED WITH AMMONIA RECOVERY PRODUCER GAS.

Particular interest attaches to a plant of three Bonecourt boilers which is now in process of erection in the Midlands. These boilers are to be fired with ammonia recovery producer gas. The general lay-out is seen by reference to Fig. 9. There are three boiler shells, each fitted with thirty-eight tubes of 6in. bore, and each capable of evaporating 11,000 lb. of water per hour. The products leaving the boilers are drawn through the tubes of a feed-water heater. Two boilers only

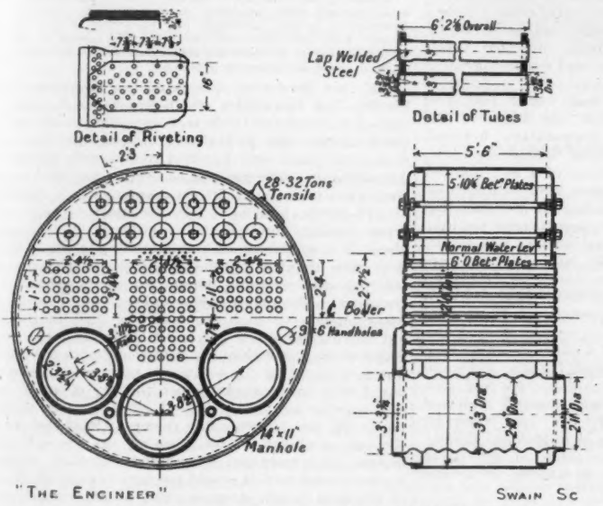



Fig. 10—BONECOURT BOILER FOR BLAST FURNACE GAS

will be in use at a time, the third serving as a stand-by. Two feed-water heaters are provided, each of which is sufficiently large to pass the products of combustion from any two of the boilers, so that at any time one feed-water heater may be put out of operation, if necessary, without stopping the plant. The pressure difference required throughout the system is maintained by one or other of two fans, one of which is directly driven by a 440-volt direct-current motor, and the other directly driven by a steam turbine. Either fan is sufficiently powerful to run the entire installation, and it will therefore be seen that the plant is duplicated both with regard to the feed-water heaters and with regard to the fans, the great object being to ensure continuity of running under all conditions. It is expected that within two months the plant will be in operation. The boiler-house measures 38ft. by 50ft. internally, and accommodates the three Bonecourt boilers and the necessary auxiliary apparatus. It is to be noted that in this particular installation plenty of space was available. Substantial margins were therefore allowed in designing the lay-out, no attempt being made to put the equipment in the smallest possible space. Had the necessity demanded it, a boiler-house 24ft. by 50ft. would have been large enough for three such boilers with all the necessary auxiliaries

From what has already been said in describing the firing of Bonecourt boilers, the general manner in which this particular installation is fired will be apparent.

### BOILER FIRING WITH BLAST FURNACE GAS.

As a preliminary to designing an installation of boilers fired with blast furnace gas, experiments were carried out at the instance of the Bonecourt Company at the works of John Cockerill, Seraing, Belgium. The blast furnace gas employed analysed :—

| | Per cent. |
|---|---|
| Carbon dioxide | 8.2 |
| Carbon monoxide | 28.4 |
| Hydrogen | 2.5 |
| Nitrogen | 60.9 |
| | 100.0 |

The calculated calorific value of this gas is 105 B.Th.U.'s per cubic foot.

With a view to determining the evaporation duty to be expected from this particular gas, a trial evaporating element was constructed, and it was found that employing a suction of 14in. water gauge an evaporation of 228 lb. of water from and at 212 deg. Fah. per hour was obtained, corresponding to 20.5 lb. per square foot of heating surface per hour. The combustion products analysed :—

| | Per cent. |
|---|---|
| Carbon dioxide | 16.4 |
| Oxygen | 2.6 |
| Carbon monoxide | 0.0 |
| Nitrogen | 81.0 |
| | 100.0 |

As the result of these tests, an installation of blast furnace gas fired boilers on the Bonecourt system is being designed for the company. Each boiler, one of which is shown in Fig. 10, will be capable of evaporating 15,000 lb. of water from and at 212 deg. Fah. per hour, and will carry three large corrugated tubes which are to be fired with the gas, the combustion products being returned through the smaller tubes after being used to superheat the steam. The shortness of the return tubes is justified by the rapid heat transmission taking place, due to the refractory packing in the tubes.

## IRON AND STEEL INSTITUTE.

No. III.*

THE first business on the second day, Friday, 8th inst., of the meeting was the presentation of the Andrew Carnegie Gold Medal which, the president stated, had been awarded to Dr. Thomas Swinden, of Sheffield, who received his training under Dr. Arnold at Sheffield University. The recipient received an award of £100 in 1909 for research work, and was granted a further sum in 1911 to enable him to carry out an investigation on molybdenum steels, and had been awarded the Andrew Carnegie Gold Medal for the results of that research. Dr. Swinden was present in person to receive the medal from the hands of the president.

It was also announced that Carnegie scholarship awards had been made to the following gentlemen:—Mr. H. B. Cronshaw, of Cambridge, who has been awarded a grant of £100 for the purpose of carrying out researches on refractory materials; to Mr. J. W. Donaldson, of Motherwell, a similar amount for the purpose of carrying out researches in the gases occluded in silicon; to Mr. R. S. G. Knight, of London, a grant of £100 for the investigation of fuel applications, transmission of heat, and heat balances in furnace operations generally; to Mr. F. C. A. H. Lantsberry, of Birmingham, £100 to investigate the heat treatment of alloy steels; to Mr. Cyril Chappell, of Aix, the sum of £100 for a research on the hot working of iron and steel; to Mr. Alexander Sander, £100 to undertake the investigation of the Feld process for the production of sulphate of ammonia in coke oven gases; and to Mr. H. M. Boylston, of Cambridge, Mass., £100 to carry out a research on the relative merits of various agents for the deoxidation of steel. Further grants of £50 have been made to Mr. J. H. Andrew, Mr. George Hailstone, and Mr. J. Allen Pickard.

Mr. Sidney A. Houghton then presented his paper, on "Failures of Heavy Boiler Shell Plates," an abstract of which is given on page 577.

Mr. Houghton, after reading the paper, said that, although there were points of scientific interest in the examples given in the paper, his chief object in calling attention to the subject was to prevent further failures. Within the past three months two more failures had occurred, one in which partial cracks had been discovered in a plate, and another in which the plate had failed under the hydraulic test. The latter was of extreme importance. He trusted that engineers would give their views on the subject of compensating rings, especially those of the flanged type. Questions in connection with annealing, the proper size of ingots, and the amount allowed for shearing also required to be dicussed. As regarded the surface defects which occurred in so many cases of failure, it had been suggested that the best method of detecting them was to electro-galvanise the plates; there was no doubt that this process did reveal flaws which might otherwise escape notice. The cost of adopting this method was stated to be very small, and an advantage was that plates so treated could be relied on to have an absolutely clean surface. The practice of annealing plates after dressing was undoubtedly a good one, as it was very effective in showing up defects not entirely removed by the dressing. In connection with the usual test pieces he hoped that anyone who had experience of ring stamping as used in America would give his views, as it appeared to be a very important matter and would be of considerable value in the practical testing of shell plates. He hoped the discussion would elicit some constructive criticism.

Mr. J. T. Milton—Lloyd's Register—who opened the discussion, said that he himself had read a paper on this subject before the Institution of Naval Architects some years ago, when he threw out a challenge to steel makers to tell them about failures in boiler plates. That challenge was taken up by two steel makers. One of these, the late Mr. Spencer, believed that many of the failures were due not to any defect in the quality of the steel, but to the imperfect treatment that the boiler plates received in the boiler shop, and the main cause he put down to the existence of internal stresses in the plates. Sir William Beardmore also implied that the cause of failure in boiler shell plates was working stresses in the plates. His own view was that these explanations did not meet the case at all. If boiler steel were of the nature of cast iron the explanation might have been accepted; but mild steel ought to stretch at least 20 per cent. before failure, and in cases where fracture had occurred in boiler shell plates there was frequently no measurable stretching whatever. He could not help feeling that at the bottom of all these cases there was a question of the quality of the metal, and that it was this, and not the stresses due to manipulation of the plates, which caused the cracks. In his own paper read before the Institution of Naval Architects he had referred to six different cases; Mr. Houghton had referred to many more, but there were many others which were not recorded. In the six cases mentioned there were three in which it was evident there was stretching in the plate. Two of these were cases of initial cracks, and most of the cracks which Mr. Houghton refers to in his paper as partial cracks were of this character. Cracks which were in the plate when delivered to the boilermaker were always oxidised on the surface, but those which occurred in the boiler shops were either extensions of original defects or, otherwise, were bright and crystalline. With regard to the stretching of the material, there were many cases of fractures in ductile material where the crack occurred without any elongation whatever. These were cases where the failure was brought about through the repetition thousands of times of small fatigue stresses. None of the examples quoted in the paper could arise from that cause. The case of an American boiler referred to by Mr. Houghton, and dealt with in his own paper, where failure occurred under the hydraulic test was, in his opinion, due to the bad quality of the metal. Attempts were made to straighten the plates, the result being that one broke into five pieces and the other into three pieces. These pieces were submitted to Dr. Arnold for investigation, and in one case it was shown that the material was of inferior quality, but Dr. Arnold's machine did not show anything wrong with the plates, which broke right across the rivet holes, although there must have been something wrong with the steel in such a case. He had supplied Dr. Arnold with a piece of good boiler plate and they had tried at Sheffield to make that steel plate bad; but although it was heated up to the point of fusion at the corners they were unable to do so. Reference might also be made to experiments carried out with plates rolled too cold, too hot, and at the proper normal temperature. Some of those treated improperly were subjected to annealing and to normalising. They were afterwards submitted to fatigue tests, and the outcome was that the worst result obtained was from the plate which was rolled too hot and had no after heat treatment, and the next worst result was from the specimen which represented the normal plate. The inference was that a good material could be obtained while allowing a large latitude in the heat treatment. With regard to initial cracks, he felt sure that they were in the ingot, and he had in his mind the case of a piston-rod in which, when the rod was forged from the ingot, the first operation revealed longitudinal markings, which on examination were found to be fine cracks. One steel maker said that the cause of these ingot cracks, or at least one cause, was the presence of bubbles near the surface, and he attributed them to the lining of the ingot mould. He joined issue because when such an ingot was rolled out into a plate these cracks would be parallel to the surface of the plate and not at right angles to it, as in the cases under discussion. A point he would like to emphasise was that made by Mr. Houghton, that boiler plates should be annealed. Everyone would agree with that statement if Mr. Houghton meant that they should be properly annealed. It would be a most dangerous thing to lay down a law simply to the effect that boiler plates should be annealed. He did not wish to frighten

* No. II. appeared May 15th.

steel makers or shipowners or marine engineers about these failures, because there had been only one recorded disaster from such a cause, the defects having always been discovered before the boiler plate was put into use. The one case was that of the Dutch steamer Pahud, in which the explosion blew out the side of the ship. A piece of the boiler plate was afterwards examined by continental experts and they could not find out any cause of the failure either by mechanical tests or by chemical assay. The ship was one of four or five sister ships and the steel for the boiler plates had all been made by the same firm. One of the plates was sent home to Europe and showed many cracks between the rivet holes, but no real cause for the failure was ever assigned. In another instance, which was that of a German steamer, three boilers were fitted, all made by a firm of great reputation. These boilers came under examination after one voyage, and in one boiler a Government official discovered some cracks on the shell plate at one edge. A piece about 1 m. square was cut out and submitted to German experts. Nothing wrong could be found with that plate. The vessel made another voyage with two boilers in service, and on her return another boiler was found in an exactly similar condition, but nothing could be found wrong with the steel used for these boilers. Following that, he himself went to the steel works where these plates were made. The German law requires all boiler plates to be annealed before leaving the works after shearing. He asked to see the annealing furnaces. The method of annealing boiler plates in those works was to pile the plates one above the other with distance pieces between them. The large annealing furnace was just large enough to take the shell plates in. The plates only showed brittleness round one seam and there was evidence that they were spoiled in the annealing furnace. If plates had to be annealed they should, in his opinion, be annealed singly, and as there were not nearly enough annealing furnaces this was a revolutionary proposal. The annealing of such plates meant something more than putting them for a few minutes in the furnace. The steel and boilers made by reputable firms should suffer no mistreatment except by accident. In the case referred to the plates were brittle round the edges and cracked between the rivet holes. He had known several other cases where similar things occurred. One instance was that of combustion chamber plates, which cracked under the rivet head. In the case of German ships the steel makers pointed out that the rivet holes were elliptical instead of being round. Experiments were carried out with stretched rivet holes, but this did not have the effect of making the plate brittle. The cracks were either in the ingot or there was something radically wrong with the steel. It was curious that cracks did occur in places on the plates where dressing had been done, and it occurred to him that dressing had been carried out on these plates to cover up defects which existed previously.

Mr. C. E. Stromeyer, Manchester, agreed with Mr. Milton in believing that most of the trouble was due to the quality of the material and not to mechanical causes. He had served about seventeen years with Lloyd's, and in those days he remembered only one case of shell plates cracking. Such cases had, however, increased enormously in recent years, especially where American and continental steel had been used. Something seemed to have got into the steel of late years which made it less reliable than formerly. He had tried to find out the reason for it, and believed one explanation was when there was present in the metal a percentage of phosphorus plus nitrogen exceeding ·08 per cent. One reason why modern steel contained more nitrogen than used to be the case was the large amount of Bessemer scrap which could be put into basic furnaces. In Canada good results had been obtained by the introduction of titanium into steel, but the difficulty of removing nitrogen by titanium was very great. The Manchester Boiler Association had been formed to prevent boiler explosions, and if Mr. Houghton or Mr. Milton would let his Association have some cracked samples he would do his best to investigate the subject. With regard to cracks round rivets, these occurred in vessels containing caustic soda. It would seem that the material cracked where it was put in tension.

Mr. David Colville, speaking from a steel maker's point of view, referred to the challenge thrown out by Mr. Milton in 1905, which was taken up by Mr. Spencer; otherwise other steel makers would have answered the challenge. Mr. Houghton had put forward reasons for segregation in steel, but there were many other causes which were known to manufacturers. These, however, were in the nature of manufacturing practice, and no steel maker was likely to disclose his practice. Mr. Milton referred to certain continental failures. He—Mr. Colville—had examined these plates and knew the cause of the failure. It was incipient disintegration and the steel was quite unfit for use. The main body of the steel was all right, but probably in the annealing furnace certain parts of the steel had been subjected to too much heat for too great a length of time. Hence the failure.

Mr. Arthur Windsor Richards agreed with Mr. David Colville that steel makers knew why certain plates failed, but were not in a position to give the whole matter away. The author stated that to eliminate the risk of failure there should be low phosphorus not exceeding .05 per cent., or with arsenic .06. That was practically telling steel makers that there ought not to be more than .01 of arsenic in steel.

Dr. J. E. Stead was inclined to believe that if Mr. David Colville knew the wonderful secret how to avert these troubles he would have to build a very high wall round his works if he wished to retain it. Mr. Arthur Richards also seemed to have something up his sleeve. It was a pity if these things were so that the secret was not revealed. If steel makers really did know all about it, then they ought to sacrifice something on the commercial side in order that the public might be saved the risk of disaster. He believed that a great many failures in boiler plates were due to the effects of crushing, which had caused the rivet heads to jump off. With the powerful hydraulic riveters used at the present day for heavy boiler plates, if the steel was allowed to cool down a little too low, rather than put the rivets back into the fire they were put under great pressure, which had the effect of crushing them up. It was important that foremen were careful not to allow the men working under them to put in rivets at too low a temperature. He had had under investigation the case of a flange of a very large thick plate which split right across during the dinner hour. That seemed to be a case of bad steel. What had happened in that case was that blunt shears had been used and the edge treated in a way which destroyed the nature of the metal. The fracture started during cooling. Reference had been made to cracks taking place at the rivet holes, and he had taken pieces of steel right in between the rivets and found the steel was good; but what did happen in very many cases was that weakness was set up during working and fractures were afterwards developed.

Mr. A. Lamberton agreed with what Dr. Stead had said as to the edge of the plate being spoiled by crushing, but that did not explain why the cracks should have gone right through the plate.

Dr. Walter Rosenhain—National Physical Laboratory—referred to the courage of the author in assigning values for the various cases he quoted. Reference had been made to attempts to make steel bad by experiment and which had failed, but that result was only a criticism of the test, and was not decisive with regard to the steel. Modern tests, if properly applied, would make any steel bad. With regard to the combustion chamber plates, the edges of the plates had been kept at a temperature between 650 deg. and 700 deg. Cent., just below the $A R_1$ point, which had set up brittleness of a well-marked kind. It was clearly due in that case to improper annealing, or perhaps the reheating for flanging had been carried out at too low a temperature for too long a time. The question of internal stresses was a very important one, and perhaps Mr. Milton's ideas were open to criticism. It had been shown by Dr. Heyn that internal stress was a factor to be reckoned with the moment the steel was subjected to cold work of any kind.

Mr. William Deighton said if a paper could be read on the failures in the corrugated furnace it should open up a discussion of great value. He had seen numerous plates which had been flanged and had split right across over-night. He was referring particularly to the tube plates of cylindrical boilers.

It was intimated that the author of the paper would reply to the discussion in writing at a later date.

A vote of thanks to Mr. Houghton was carried with acclamation.

A paper by Mr. Fritz Müller on

"The Development of Dry Cleaning in Blast Furnace Gas Purification"

was presented by the Secretary in the absence of the author. The paper, as will be seen from the abstract below, is devoted to the plant known as the Halberger-Beth.

The gas coming from the blast furnace contains about 10 to 20 grammes of dust per cubic metre, the heaviest particles of which, and therefore the richest in iron, separate first and are deposited in big dust-catchers or mains, from which the accumulations can easily be drawn off whilst working. This dust, which contains a considerable proportion of iron, is either agglomerated or briquetted, and is charged again into the blast furnace.

On its way to the cleaners the crude gas is cooled down approximately to the dew-point in a surface cooler placed in front of them; if the temperature of the gas is very high, or in hot weather, the efficiency of this surface cooler is increased by the injection of finely sprayed water. After passing the cooler, the crude gas, which still contains more than 5 grammes of dust, is led through a superheater, where by means of steam or burnt waste gases its temperature is raised by some 10 deg. to 20 deg. Cent. The superheated gas then rises through a distributing pipe into a system of filter boxes, the number of which depends upon the size of the plant. In the different chambers, which can be shut off from one another independently, filter bags made of special cloth are suspended. The lower end of each bag is fastened in a frame in the bottom of the compartments, whereas the upper closed end is suspended on a movable cross-bar, which keeps the bag stretched during working. The crude gas is drawn by exhaust fans into the interior and through the cloth of the bags, to the inside of which the dust remains clinging. The cleaned gas is passed straight on by the fans to its destination without any further treatment, except that the gas used for driving gas engines must first be water-cooled.

The dust deposits in the inside of the bags, and it is therefore necessary, in order to prevent their complete choking, to shut off and automatically clean each chamber at regular intervals.

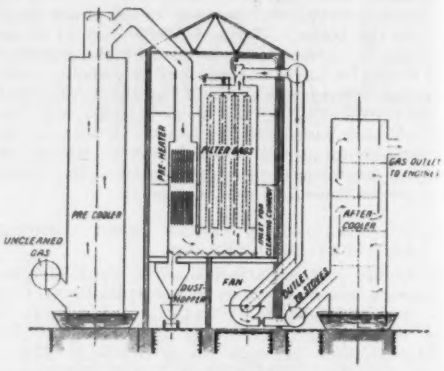
A special mechanism shakes the bags, whereby part of the dust is removed and at the same time a stream of clean gas at a higher pressure than that of the crude gas current is blown in the opposite direction through the bags, that is, from outside to inside.

The cooling down of the gas to nearly the dew-point ensures that the cloth of the filter bags will not be destroyed by the heat, and, on the other hand, the slight superheating prevents the condensation of vapour when the gas is passing through the bags, so as to avoid choking them up.

It is claimed that the gas is of a higher purity than has ever before been obtained by any other cleaning system; secondly, the working costs are very low owing to the low power and water consumption.

The gas after passing the filter chambers generally contains about 3.5 milligrammes of dust per cubic metre, which falls below 1 milligramme when the gas is cooled down with water to serve for gas engines. No water is injected into the fan, and the latter has therefore only to overcome the resistance of the filter bags. Consequently its power consumption is far lower than that of corresponding fans in wet cleaning processes.

Naturally a dry cleaning plant cannot be cheaper, as to first cost, than a wet cleaning plant; the first cost is somewhere about £175 per 1000 cubic metres of gas, but trials are in progress which will result in a considerable reduction of the first cost by increasing the capacity and simplifying the mechanism of the plant. On the other hand, the dry cleaning plant has the advantage of low working costs, which are about 1d. to 1¼d.




MODEL OF DRY GAS CLEANING PLANT

per 1000 cubic metres of cleaned gas, without redemption and interest, the power being taken at 0.375d. per kilowatt-hour. This is without taking account of the advantages obtained by using highly cleaned gas.

Another point in favour of the dry cleaning plant is the very small ground space required, since it extends more in the direction of height; generally not more than 4 to 5 square metres (40 to 50 square feet) per 1000 cubic metres of gas are required, whereas wet cleaning plants require two or three times as much space, including the settling tanks.

Mr. Greville Jones, in opening the discussion, said his firm had installed a small experimental plant on the system described. It was intended for the use of blast furnace gas in the steel works, and for that reason the plant only handled 10,000 cubic metres of gas per hour. The gas was carried to the steel works through a tube about 3ft. in diameter for a distance of 476 yards, and as it left the blast furnace end, after passing through dust catchers, it contained about 5·6 grammes of impalpable powder. Along that tube about a gramme was lost, so that the gas entering the cleaning point contained about 4·5 grammes. The maximum found was 5·29 grammes. After passing through the bags the dust in the gas did not exceed 0·035 grammes. His firm was using rather more power than the author stated in the paper, but that might be due to a lower pressure of gas compared with other works where the dry cleaning process was in use. The cost of cleaning was slightly under 2d. per 10,000 cubic metres. With regard to the use of the plant for cleaning gas for stoves or boilers, he questioned very much whether, looking to the capital cost, it would pay any firm in the North of England to put down a plant of that description. His firm was at present trying the use of the clean gas under a boiler, but the results obtained were nothing like they were led to expect. Perhaps, however, with a proper water-tube boiler instead of the Lancashire boiler used, better results would be obtained. Were he putting up a big installation and introducing gas engines, he would have no hesitation in putting in the dry cleaning plant rather than the wet.

Mr. A. Gouvy was of opinion that the cleaning of blast furnace gas was one of the most important improvements effected during the past few years. The primary point was the recovery of power in the gas engine, which was a question which interested all works managers who were seeking to reduce their costs. The wet cleaning of gas had several disadvantages, and in all cases where the temperature was not over 200 deg. the dry cleaning process possessed advantages.

Mr. D. Neustadter said that Mr. Müller had asked him to answer questions in connection with the Halberg-Beth plants. Mr. Greville Jones' higher working costs were explained by his having a rather small plant, which was worked intermittently, as it served for firing a steel mixer and open-hearth furnaces. Mr. Jones' inability to obtain as good results when experimenting on Lancashire boilers as those of other users of highly cleaned gas would be made clear when it was considered that only one boiler, and that next to a cold boiler, had been worked in this way by him. He did not agree with Mr. Jones that gas cleaning did not pay without having steel works or other use for the surplus gas.

Mr. Walter Dixon said that everybody was now quite agreed that blast furnace gases must be cleaned if reasonably economical working was to be attained, and, further, that if the gases were required to be used in engines they must be cleaned as perfectly as possible. The question of the relative merits of dry

or wet cleaning was one of circumstances. What he particularly wished to state was that while many had confined their attention to the cleaning of blast furnace gases, he, along with others interested in the matter, had for some time past devoted attention to another phase of the question. That was, not how to take dust out of the gases but how to prevent dust getting into the gases, on the principle of prevention being better than cure. They had so far been able to modify, without any great expense, certain types of blast furnaces so as to render exterior cleaning of the exit gases unnecessary, except where they were required for use in engines, the gases for which, however, so far as this country was concerned, formed a comparatively small percentage of the whole output. The system appeared to have the possibilities of a cheap and effective method of rendering gases sufficiently clean to enable boilers, stoves, &c., to be run continuously over long periods.

Mr. John A. Smeeton said that if the Halberg-Beth dry cleaning plant could make gas ten times cleaner than any wet process with a less power consumption and cost, then it was purely a matter of added efficiency *versus* finance. Many boilers working on uncleaned blast furnace gas were only giving 40 per cent. efficiency; the same boilers fired with dry cleaned gas gave 70 per cent. efficiency. A saving of that order was extremely important, not only because it increased the value of each unit, but because it reduced the number of units required for any special purpose, and released those previously required for other purposes. The same might be said of the Cowper stoves, soaking pits, heating and melting furnaces, and gas mains, all of which derived considerable benefits from a highly cleaned gas. Whether it paid to install a gas cleaning plant for blast furnaces only could not be decided without careful investigation into each set of conditions. The maximum saving was obtained by the use of the gas released from the Cowper stoves, owing to their increased surface efficiency. In some cases works could not find use for the whole of this gas, in which case it was not necessary that the gas for which they had no use should be cleaned. There was also a saving in coke at the furnaces owing to the increased blast temperature at an even pressure and a very considerable saving in stove, flue, and gas tube cleaning, which cleaning was practically eliminated by dry clean gas. There should also be added the value of filter dust, which was only obtained from a dry process plant.

Mr. E. Hall Brown thought that the comparisons which had been instituted in the paper between the dry cleaning system of Halberg-Beth and the wet cleaning systems, notably that of Theisen, were hardly fair to the latter. He only knew of one installation of dry cleaning plant in this country. While he was fairly satisfied with the results at present obtained in the purification of blast furnace gas for use in gas engines, it seemed clear that none of the present systems of gas purification exactly met the case of gas cleaning for boilers and stoves. The degree of purity attained was, of course, quite satisfactory, but no one could justify the enormous waste of heat entailed by the cooling of the gas as a necessary preliminary to its purification. He was satisfied that sufficiently pure gas could be produced for those purposes without the sacrifice of the sensible heat which the gas contained when it left the furnace. It was with the object of saving that heat that they were at present experimenting, and there was more than an indication that in the very near future they would be able to put on the market a gas purifying plant which would purify hot gas and enable all the sensible heat to be utilised in useful work instead of dissipating it into the atmosphere or allowing it to escape in drainage water as at present. Until that desirable consummation was attained they believed that the conditions to be fulfilled by gas cleaning plants in this country could in most cases be met by a wet cleaning plant, which, among other advantages, had undoubtedly that of lower first cost

The next paper taken was

"SOME RECENT IMPROVEMENTS IN CASE-HARDENING PRACTICE,"

by Mr. Henry S. Heathcote.

In this very interesting and instructive paper the author described the development, under his own hands, of certain processes employed at the Rudge-Whitworth works at Coventry. In the improvement of case-hardening methods the first difficulty met was the measurement of temperature. An "efficient pyrometric outfit" for a battery of thirteen muffles was very costly to purchase, and would have cost something in upkeep. Eventually, after various experiments with the spectroscope, which were promising, but directly fruitless, it was found that "a solution just capable of absorbing all the coloured rays from steel at, say, 760 deg. Cent. would transmit the excess intensity and extra wave lengths of the rays emitted at 800 deg. Cent., and the object would be visible." A long series of experiments was then begun to find the right colours to employ, and then to get a permanent dye solution. Success has been attained in both directions, and the pyrometers are simple cells of dyes mounted in suitable holders through which the treated body is observed.

Mr. Heathcote then discusses in his paper the nature of case-hardening compositions and their permanence. He has found one composed of wood charcoal impregnated with soda ash the best.

Another thing Mr. Heathcote has investigated is the measuring of hardness, and he has devised an ingenious sclerometer which, unlike all others, measures the resistance to abrasion rather than to compression. It consists of a pair of files hinged together at their ends. One file is placed horizontally and the other is free to swing in a vertical plane. If a roller of any material whose hardness is to be tested is placed between the two files, the upper file will descend until an angle of repose dependent upon the hardness of the specimen is reached. The smaller the angle, the greater the hardness. Mr. Heathcote's is a thoroughly practical workshop paper.

Professor Turner said the industry with which Mr. Heathcote was connected was a very important one, although it dealt with relatively small articles, and

THE HEATHCOTE HARDNESS TESTER

it was necessary that the wearing surfaces should be hardened in a proper manner and with a uniform hardness. The subject of case-hardening was being put upon a more scientific basis, and there was every chance of more uniform results being obtained.

The last paper taken was

"THE PRODUCTION OF STEEL DIRECT FROM ORE,"

by Messrs. Ernest Humbert and Axel Hethey.

The authors have come to the conclusion that with the aid of the modern electric furnace, and given satisfactory conditions, the economic manufacture of steel direct from ore is a practical possibility. The material produced will be superior to that manufactured by present methods, and will have properties of the greatest importance and value to the steel user. A special type of furnace will probably be developed, although the standard Héroult furnace is satisfactory for occasional charges. The charge should lie deep in the furnace to permit violent ebullition of the bath without overflowing. Anthracite electrodes will probably be found most satisfactory owing to their freedom from breakages. The best use for this process will be found in countries that possess readily available sources of water power together with deposits of pure rich ores. Charcoal, coke, or anthracite coal can be used as fuel. In countries where cheap power, produced from waste heat such as blast furnace gases, coke oven gases, &c., can be obtained, its most useful sphere will probably be found in making high-grade steels for springs, drills, and similar tools, shafts, and all grades requiring exceptional toughness.

Mr. E. G. Constantine pointed out that if nitrogen had a detrimental effect on the quality of steel used in boiler plate, and if by such a process as that described in the paper nitrogen could be eliminated it was well worth the consideration of those who manufactured boiler plates, whether they could not introduce a system of the kind in their works.

Mr. Otto Frick reminded the Conference that the process had been tested twelve years ago in a most exhaustive manner by Stassano, with the very best results technically, but it was practically certain that the process could not be economically worked.

Mr. Harbord also expressed the opinion that if steel was to be made direct, as it might possibly be made under exceptional circumstances, the Héroult furnace lent itself better to the process than any other furnace. He did not consider that steel would ever be made under commercial conditions direct in the electrical furnace from ore, except in special conditions where small quantities were wanted, and possibly in countries where they were developing slowly and where they wanted a small output to meet a local demand. In competition with modern blast furnaces and modern steel plants it was quite impossible commercially to make steel direct in an electric furnace.

The other papers on the agenda were taken as read.

The Conference terminated with the usual votes of thanks.

## DOCKYARD NOTES.

THE shipbuilding firm of Augustin Normand, of Havre, has just received an order from the Ottoman Government to construct twelve torpedo-boat destroyers, six of which are to be built at once and the remainder in three years. The principal particulars of these vessels are to be:—Length between perpendiculars, 87.5 m.; displacement, fully loaded, 1040 tons; oil fuel capacity, 200 tons; speed during six hours' trial, 32 knots. These vessels are each to be fitted with Parsons turbines, of 22,000 horse-power, supplied with steam from four boilers having a total heating surface of 2400 square metres (say, 25,800 square feet). The armament is to consist of five 100 mm. guns, and six torpedo tubes 533 mm. (say, 21in.) in diameter. The cost of each boat is about 4,000,000f. (say, £160,000).

IN the current Navy List no fewer than nineteen warships of various types are given as "to be sold." The list is as follows:—Hood, receiving ship, 14,150 tons, Portsmouth; Revenge (old), battleship, 14,150 tons, Motherbank; Britannia, late training ship for naval cadets, 6201 tons, Dartmouth; Colleen (old), coastguard cruiser, 416 tons, Devonport; cruiser (late Lark), sailing sloop, 1130 tons, Malta. Light cruisers: Æolus, 3600 tons, Chatham; Cambrian and Flora, 4360 tons each, Devonport; Perseus, 2135 tons, Chatham; Promotheus, 2135 tons, Devonport; Terpsichore, 3400 tons, Motherbank. Destroyers: Foam, 340 tons, Devonport; Handy, 290 tons; Janus, 320 tons, Hong-Kong; Otter, 385 tons, Hong-Kong; Taku, 305 tons, Hong-Kong; Virago, 395 tons, Hong-Kong; Whiting, 360 tons, Hong-Kong; and Zebra, 340 tons, Sheerness.

ACCORDING to the *Naval and Military Record*, on the occasion of the fifth destroyer coaling at Malta on the 30th ult., the following quantities were received at the rates shown:—

| | Tons. | Average per hour. |
|---|---|---|
| Scorpion | 190 | 140.7 |
| Mosquito | 195 | 137.6 |
| Savage | 18 | 127.0 |
| Foxhound | 153 | 110.6 |
| Renard | 175 | 110.5 |
| Grampus | 228 | 101.4 |

The averages show considerable improvement, as the best average previous to this was that obtained by the Harpy on April 23rd, when she received 200 tons at the rate of 126.3 tons per hour. A very few years ago 50 tons was a record.

THE new German cruiser Karlsruhe has successfully completed her trials. On the six-hour full-power run with moderate forced draught her mean speed was 27.6 knots. The Rostock, of the same class, which has also been on her trials, attained a maximum speed of 29.21 knots. Both ships are fitted with Parsons turbines and Schulz-Thorny-croft boilers. Their armour is a belt of about 4¼in., with deck and bunker protection. Their armament is twelve 4.1in. and two 20in. torpedo tubes, submerged. Other vessels of this class are the Grandenz and Regensburg, the latter of which was launched a fortnight ago. Those still being built are the Ersatz Gefion, Ersatz Hela, Ersatz Gazelle, and Ersatz Niobe.

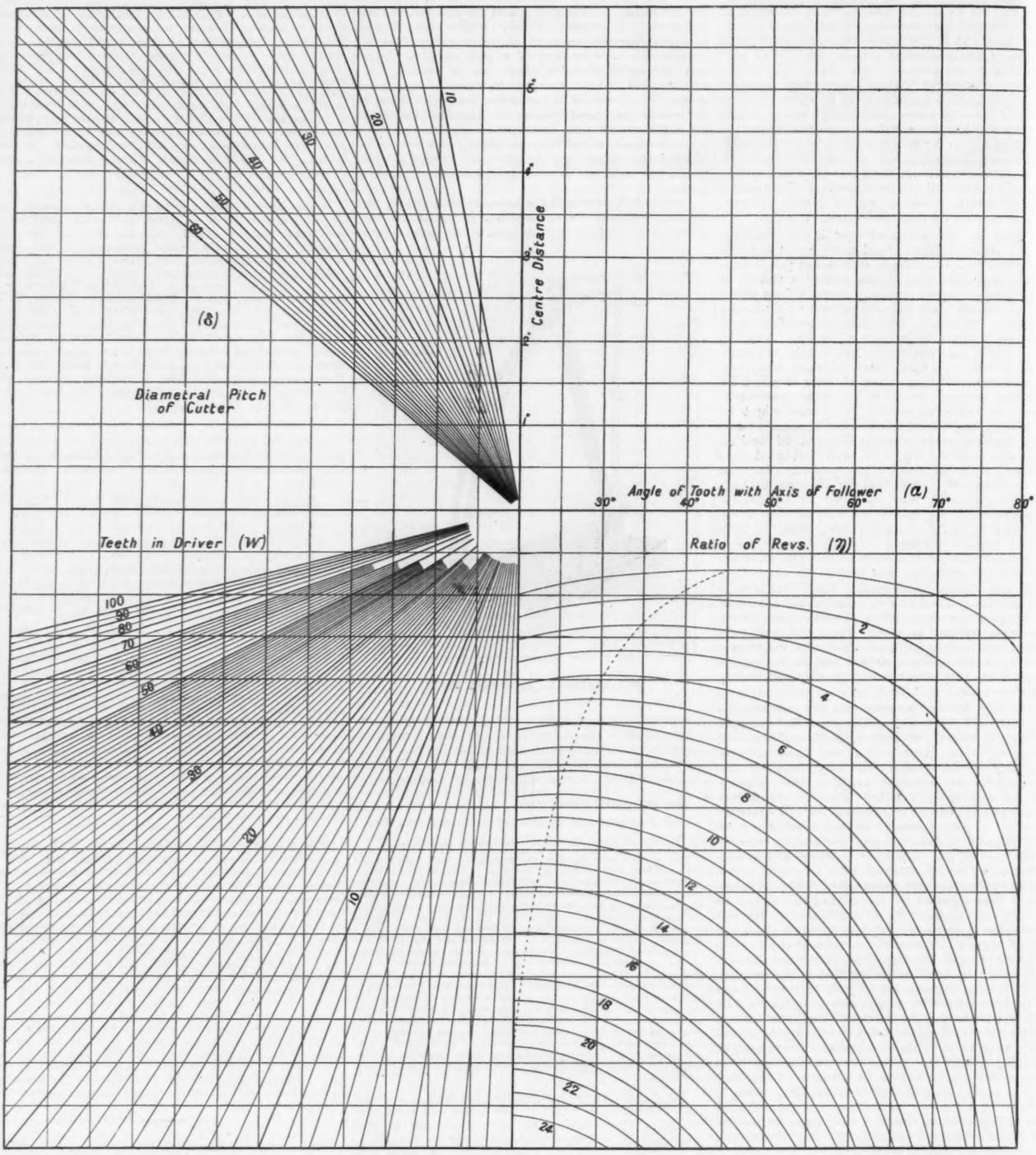
THE French submarine Nereide, of 800 tons, speed 20 knots, was launched at Cherbourg on May 9th. She is fitted with two-stroke Diesel engines of the Schneider-Carels type, which develop 2400 horse-power. The motors have eight cylinders. Her dimensions are 239¼ft. by 19¾ft. by 15ft. She will have ten tubes or dischargers at various angles. A novelty is a movable conning tower, which is raised and lowered by hydraulic power. In theory this is excellent, but the question arises as to whether leaks may not occur when the boat has been doing considerable service at sea. Another boat of the class is the Gustave-Zédé.

THE Austro-Hungarian scout-cruiser Saida has started on her trials. She is an enlarged sister to the Admiral Spaun. Her displacement is 2500 tons and her speed is estimated to exceed 27 knots. Her armament is nine 4in. 50-calibre guns and two 18in. tubes. The armour is a nickel steel belt amidships 2.3in. thick, reinforced by a 1in. protective deck.

THE light cruisers Szigetvar, Aspern, and Zenta, which were launched in 1897–99 and have a displacement of 2350 tons, are, it is said, to be "completely reconstructed with a view to increasing their speed. Instead of their triple-expansion engines and old Yarrow boilers, they are to be fitted with turbines and new Yarrow boilers for mixed firing, and it is hoped to bring their speed up to 27 knots instead of 20 knots as formerly." This, if successful, would constitute a record in reconstruction. We are inclined to fancy, however, that some humorist has been at work.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS.—The Association of Teachers in Technical Institutions will hold its eighth annual conference at Liverpool during Whitsuntide, May 30th to June 3rd. The educational meetings will be held in the large hall of the Central Municipal Technical School. The open meetings begin on Monday, June 1st, at 10.30 a.m., when the chairman of the Liverpool Education Committee, Councillor J. W. Alsop, will welcome the conference to Liverpool, and the president, Mr. P. Abbott, will deliver his presidential address. During the conference papers will be read by Mr. W. Hewitt, the Director of Technical Education for Liverpool, Professor Haldane Gee, Mr. W. E. Harrison, Mr. Laurence Small, Mr. W. R. Bower, and others. Sectional meetings will be held on the afternoon of June 2nd, when papers of special interest to the various sections of technical education will be read. The annual dinner will be held at the Exchange Station Hotel on the evening of June 1st. Visits to Port Sunlight and to Cammell, Laird and Co.'s works and a reception by the Lord Mayor at the Town Hall are amongst the items which have been arranged by the Conference Committee, and an exhibition of books and scientific apparatus will be held throughout the conference at the technical school.

SPIRAL GEAR DIAGRAM, No. I.



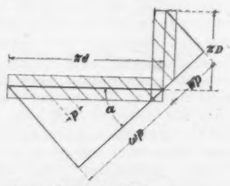

## SPIRAL GEARS: A PARTICULAR INSTANCE IN A NEW SYSTEM OF GRAPHS.

By MARK BARR.

WHEN we have solved the difficult problem of efficiency and attrition in spiral gears there remains the troublesome task of stating the geometrical details. Probably the best contribution to the theory of efficiency is that of Mr. Lanchester, and we would do well to adopt his theory in designing our cutters. In THE ENGINEER it is unnecessary to emphasise the point that the word theory is here applied to the concrete and best actual thing made and working, and not to the hypothetical or unobtainable thing. The word Practical has ceased to deserve the merit given to it by those horny-handed people who fill the world with wrecks. I would not modify my praise of Mr. Lanchester; his method is to consider absolutely all facts that may be related to a subject and to include them in what I hope he calls the theory of his splendid work.

The simpler geometric problem of the drawing-office is that of finding an angle, within the range of best angles, which will suit the required ratio of revolutions consistent with strength, efficiency and economy. Fig. 1 is a diagram showing the peripheries of two spiral gears at right angles. We see that

$$\frac{\omega p}{\pi d} = \cos \alpha \text{ and } \frac{W p}{\pi D} = \sin \alpha.$$




$d$ = *diameter follower.*
$\omega$ = *teeth follower.*
$D$ = *diameter driver.*
$W$ = *teeth driver.*
$p$ = *circular pitch of teeth.*
$\delta$ = *diametrical pitch of cutter.*

**Fig. 1**

But as the diametrical pitch, $\delta = \frac{\pi}{p}$, we have

$$\frac{\omega}{d\,\delta} = \cos \alpha \text{ and } \frac{W}{D\,\delta} = \sin \alpha,$$

so that twice the centres distance

$$2c = \frac{\omega}{\delta \cos \alpha} + \frac{W}{\delta \sin \alpha}$$

$\left(\text{wherein the ratio of revolutions } n = \frac{\omega}{W}\right)$.

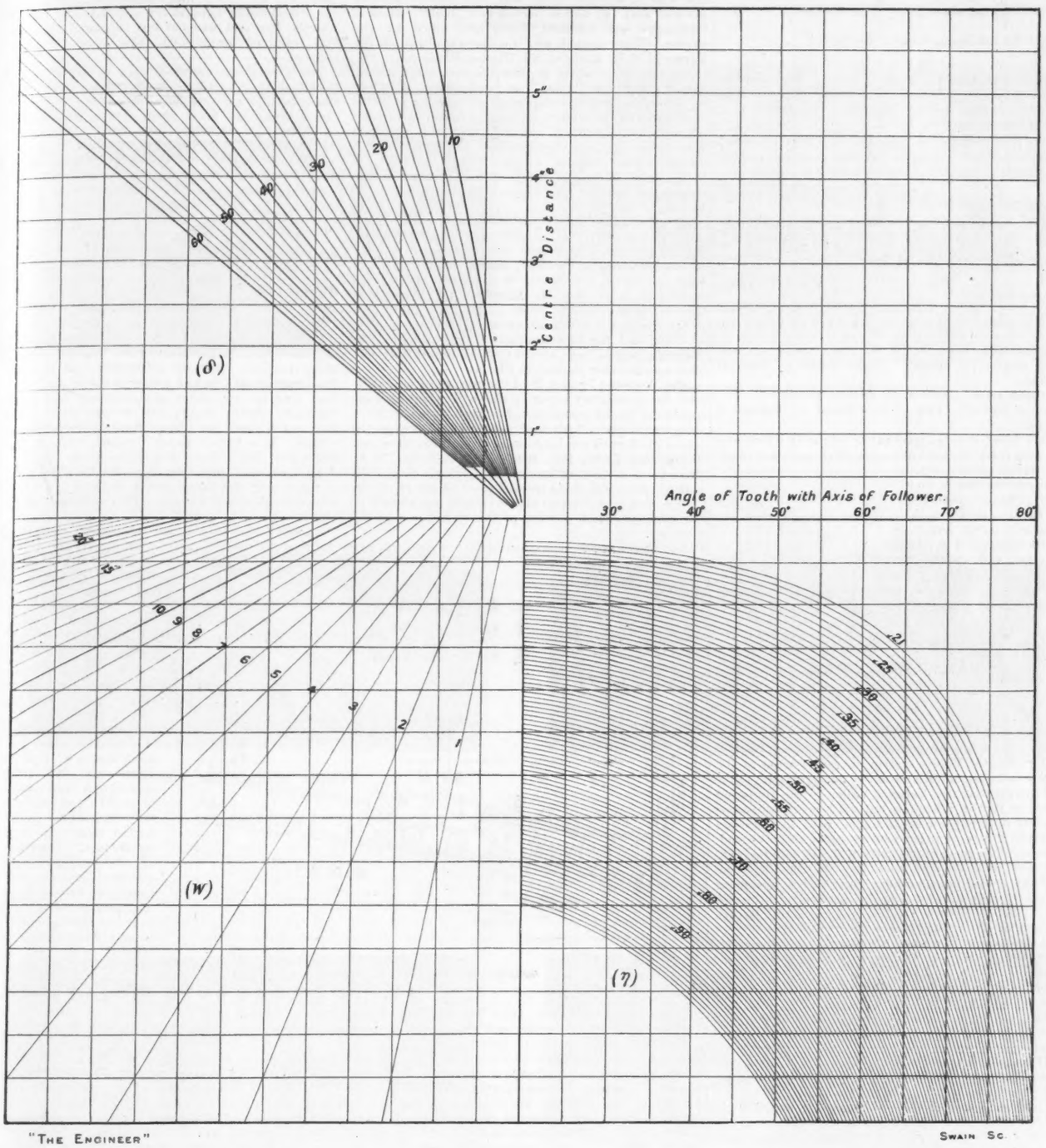
This is the fundamental relationship, and when we have chosen suitable numbers and have selected a cutter of a diametrical pitch that we may find in stock, we must see what angle is compatible with our requirements.

There are various ways of manipulating the equations, but whatever we do, there remains the difficulty of matching two numbers which can only be found in two different columns of a trigonometrical table. One simple form is

$$\frac{2c\,\delta}{W} = n \sec \alpha + \operatorname{cosec} \alpha \text{ii} \quad \ldots \quad (1)$$

Graphic methods have been employed in problems of this kind; but even those of d'Ocagne and Hering do not go beyond combined quadrants. That is to say, there are methods of putting several systems of Cartesian quadrants back to back so that one may

## SPIRAL GEAR DIAGRAM, No. II.




read across from one set of variables to another. But this has been *only possible with graphs that have common ordinates or abscissæ*, and in the case of spiral gears—and other problems of greater complexity—this method fails to give solutions that are free from trial and error. Therefore one might as well use equation (1) and try for a solution in the usual way.

The graphs shown, in reduced scale, in Diagrams I. and II. are drawn by a method I devised in June, 1902, for problems in which any number of variables may appear and where any one variable may be unknown. As far as I know it is an original method. I hope to make up a book showing varied examples of its application and to give an extended theory of the method as applied to intricate processes.

The case of spiral gears illustrates the use of the new system, but there are supplementary relations in the complete theory—such as quadrants containing what I call "refraction graphs" and "conversion graphs"—which cannot be treated in detail here.

*The μ System of Graphs.*—Take equation (1). Obviously, it is impossible to deal with this in a single system of co-ordinates. But by the μ method we may take one pair of variables at a time, provided we deal with them as *partials* and introduce an axis, the values of which will cancel out as we go on. Thus we may write—

$$\Sigma\, c\, \delta = \mu = W\,(n \sec \alpha + \operatorname{cosec} \alpha),$$

and begin by plotting graphs between scalar co-ordinates $c$ and $\mu$ for as many values of $\delta$ as we choose. Thus:

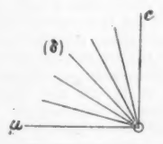



Fig. 2

Now, as

$$\mu = W\,(n \sec \alpha + \operatorname{cosec} \alpha),$$

and assuming a new axis $\mu^1$ so that

$$\mu^1 = n \sec \alpha + \operatorname{cosec} \alpha$$

we have

$$\mu^1 = \frac{\mu}{W}.$$

Drawing the new scalar axis $\mu^1$ at right angles to $\mu$, we plot graphs between $\mu^1$ and $\mu$ for as many values of W as required. So far, this gives Fig. 3. We have also the relation

$$\mu^1 = n \sec \alpha + \operatorname{cosec} \alpha,$$

and now drawing a scalar axis for $\alpha$ at right angles to $\mu^1$ we plot the latter equation for as many values of $n$ as we choose, thus giving the complete system

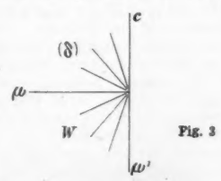



Fig. 3

of graphs as shown in Diagrams I. and II. The values of $\mu$ and $\mu^1$ were temporary devices and so do not appear.

The figures shown illustrate the method, but for extended use other graphs should be drawn with different ranges. Of course, this case is simplicity itself; but in problems involving logarithmic trigonometrical relations or differential relations the usefulness of the μ system is more striking. Any number of μ axes may be employed, and on occasions it is possible to introduce special operator quadrants in which single curves appear for the purpose of converting certain functions.

While we are on the subject of spiral gears it is interesting to observe a curious fact brought out by

differentiating the expression for $c$ (the centres' distance) in regard to $\alpha$ (the tooth angle) and equating to zero.

$$\frac{d\,c}{d\,\alpha} = \frac{n\,W}{\delta}\tan\alpha\,\sec\alpha - \frac{W}{\delta}\cot\alpha\,\mathrm{cosec}\,\alpha,$$

so that for minimum centres' distance

$$\cot\alpha = \sqrt[3]{n}.$$

From this amusing relation we can find whether a chosen centres' distance is possible or not. The loci of minimum centres' distances are shown by a dotted line in Diagram No. 1.

*Case II.: Shafts at any Angle.*—It is only necessary to write down the equations for this case and to give the simple $\mu$ operations required for the graphs.

$$2\,c\,\delta = W\,(\mathrm{cosec}\,\alpha + n\,\mathrm{cosec}\,\beta),$$

where

$\alpha$ = angle between tooth and plane of follower,
$\beta$ = angle between tooth and plane of driver,

and other symbols are as above, we have :—

Quadrant I.:
Axes $c$ and $\mu$. Plot $2\,c\,\delta = \mu$. Various $\delta$ values.

Quadrant II.:
Axes $\mu$ and $\mu'$. Plot $\mu' = \frac{\mu}{W}$. Various W values.

Quadrant III.:
Axes $\mu'$ and $\mu''$. Plot $\mu'' = \mu' - \mathrm{cosec}\,\alpha$. Various $\alpha$ values.

Quadrant IV.:
Axes $\mu''$ and $n$. Plot $\mu'' = n\,\mathrm{cosec}\,\beta$. Various $\beta$ values.

This gives a four-quadrant $\mu$ graph in which the first axis reads centres' distances, first quadrant reads diametrical pitches, second quadrant number of teeth, third quadrant tooth angle of first wheel, fourth quadrant tooth angle of second wheel, and in which the last axis reads the ratio of revolutions. Obviously, by taking intersections any variable may be treated as unknown and found.

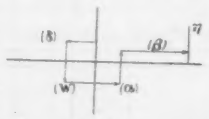


Fig. 4

## RAILWAYS IN CHINA.

*(By our Special Commissioner.)*

No. III.*

### SHANGHAI-NANKING RAILWAY.

THIS line is particularly interesting as being the key to the Yangtze Valley system, or rather what of the system is constructed and under construction. It is well known that the Yangtze Valley is the supposed sphere of British influence, but various complications arose at different times, and what with the pressing of claims firmly by other Governments and a characteristic yieldingness on the part of the British Government, it may be said that the Shanghai-Nanking Railway is the only complete line left to represent purely British interests in the matter of railways. It is run on British capital and made by British engineers. It is not in the scope of this article to go into the various questions which arose and the resultant minimising of British operations. They are clearly set forth by Mr. Kent in his book "Railway Enterprise in China," and they have been the subject of many questions in the House of Commons. That British interests have fared badly and that British official weakness was the main cause are points generally conceded.

The main line from Shanghai to Nanking is 193 miles long, and the Woosung branch 10 miles, which makes the total of 203 miles.

The story of the Woosung line is romantic. As far back as 1865 a scheme was formulated for the building of a railway from Shanghai to Woosung. Shanghai is on the Huangpu River, while Woosung is at the junction of that river with the Yangtze. The object of establishing railway communication between the town of Shanghai and the anchorage of Woosung was ostensibly to provide an object lesson in railways for the education of the Chinese. This scheme met with such opposition that it fell through. It was next proposed by Messrs. Jardine, Matheson and Co. to go quietly to work "making a road" between Shanghai and Woosung, and the consent of the Chinese Government was obtained for the purpose. The Woosung Road Company was formed, and it set about buying up land, but this was so costly that the total capital of the company was nigh exhausted in the process. In 1875 Mr. Rapier, of Ransomes and Rapier, suggested the laying of a narrow-gauge (30in.) line and working it with small engines, and ultimately this suggestion was adopted. Rails of only 26 lb. per yard were laid on the "road," and the scheme carried to completion by Mr. John Dixon as contractor, Mr. G. J. Morrison being the resident engineer. The work was commenced early in 1876, and official protests were soon made on the ground that only a road was authorised and a railway was being built. The engine was stopped, but the laying of the line was proceeded with.

With that vacillation characteristic of the Chinese, the opposition was withdrawn and re-imposed several times, and at length, on June 30th, 1876, the line was officially opened as far as Kangwan, a distance of about five miles. The remainder of the line was meanwhile being laid, and success seemed assured and opposition withdrawn finally, when a Chinaman was knocked down and killed by the engine. Riots ensued, and the line was closed on the advice of H.M. Minister, Sir Thomas Wade.

Negotiations ended in the Chinese Government taking over the "road" at cost price. Pending payment the line was reopened in December of 1876. In October of 1877, when the final payment was made, all traffic was stopped. Shortly after this the rails were taken up and, together with the carriages and engines, were shipped to the Island of Formosa to be dumped into the sea there, and a temple to the Queen of Heaven was erected on the site of the Shanghai station.

This line was rebuilt by Chinese with Chinese capital and opened for traffic in 1898, and was ultimately, by arrangement with the concessionaires of the Shanghai-Nanking Railway, taken over as part of that concern at a valuation of £125,000. It is satisfactory to know that Mr. Morrison, the engineer of the Woosung "Road," lived to take a leading part in the drafting of a new and enlarged scheme. He died in 1905, and the first locomotive on the Shanghai-Nanking Railway was named Gabriel James Morrison. This was the first railway in China.

The Woosung branch is of the nature of an extension, for up-country export traffic will, when arrangements are finally completed, be taken direct to Woosung and shipped there, and, conversely, it is expected that a good trade will be done by ocean-going steamers discharging direct into trucks at Woosung. With this object in view extensive sidings have been built and wharves and sheds erected close on the riverside. If this idea is developed the Woosung line should be the most profitable portion of the Shanghai-Nanking Railway.

The agreement for the construction of the main line was entered into in July, 1903, between the Chinese Government and the British and Chinese Corporation, Limited. An agreement of this kind is usually preceded by the acquisition of certain rights. In itself it is simply an undertaking on the part of the contracting company to raise a certain sum of money by the issue of bonds to be endorsed by the Chinese Government. In this respect the company is merely an underwriting institution, and for performing this service receives certain commissions and other considerations. The commission on the issue of the bonds is an uncertain quantity in some cases, dependent on the state of the money market at the time. In other cases it is fixed by the agreement.

In consideration of raising the loan the right is formally granted to construct and equip the line, and a sum, usually amounting to about 5 per cent. of the cost, is allowed for this work. The company or syndicate becomes trustee for the bondholders, and in some cases until the whole loan is repaid has a lien as mortgagee in possession on the undertaking with the additional security of the guarantee of the Chinese Government as endorsed on the bonds. In other cases the bonds are secured by the appropriation of certain Government revenues.

The company or syndicate has the nomination of the engineer-in-chief, who is thereupon engaged by the representatives of the Chinese Government. It cannot be too clearly understood that the undertaking is that of the Chinese Government, that the railway is a Government concern, and that all the officials, including the engineer-in-chief, are servants of the Chinese Government.

These conditions, with certain modifications, apply to all Chinese Government railways, and I have thought well to mention them here in order that some idea of the general situation may be gained.

The amount of loan stipulated for with the British and Chinese Corporation, Limited, for the Shanghai-Nanking Railway was £3,250,000, of which £2,900,000 has been issued.

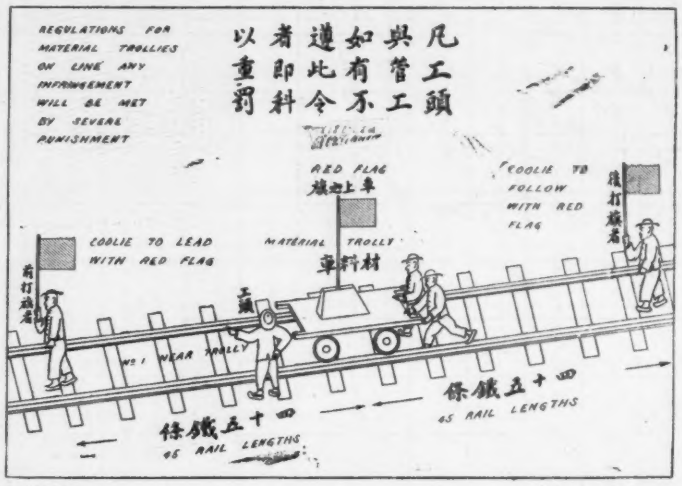
Mr. A. H. Collinson was appointed engineer-in-chief, and the survey was completed in 1904. There was considerable delay in the acquisition of the land, and the first sod was not cut till April 25th, 1905. The standard gauge (4ft. 8½in.) was, of course, adopted.

The railway was opened in the following sections :—Shanghai to Nanziang, on November 20th, 1905; Shanghai to Wusih, on July 16th, 1906; Shanghai to Changchow, on May 15th, 1907; Shanghai to Chinkiang, on October 15th, 1907; Shanghai to Nanking, on March 28th, 1908.

The country is for the most part flat, and the line runs between a branch of the Grand Canal and the Yangtze River, practically alongside one or other of them for the whole distance, and every foot of the land, except where graves prevent it, is closely cultivated. There are several important cities near the railway, and villages every mile or less.

In the matter of alignment the longest, straight lengths possible were aimed at, but this was often frustrated by the existence of graves too important to be moved. It is no uncommon thing to come on a kink in the line, for which the only reason is the avoidance of some ancestral tomb. It is impossible to convey any proper idea of the number of graves along this line. It is well within the mark to say that one-tenth of all this rich valley is taken up by them. And they are put about promiscuously, not grouped together. Every family has its own patch, and in that patch there are places more distinguished than others. In a former paper I made a remark to the effect that the country seemed to be devoted to the dead more than the living, but here it is a dead man's country with the living trying to grow a bit of rice where the dead will let him. This is the only scenery, and it is tiresome enough.

It was expected that this line would join up with the Kiangsu line by way of Kashing, for this was part of the Yangtze Valley scheme; therefore a double line formation is made as far as Soochow (54 miles). This object, however, is not now likely to be realised.



COOLIES' INSTRUCTION DIAGRAM

The ruling gradient is 1 in 200, and the proportion of this to the whole line is only 2.9 per cent. The sharpest curve is 3 deg., and the ratio of curve to the main line is 9.75 per cent. There are 303 bridges spanning a total waterway of 5857ft., and 405 culverts for irrigation purposes with a total area of 1992 square feet. The majority of the bridges are of coursed granite set in cement on cement concrete foundations, or of cement concrete throughout. The weight of steel bridge work erected was 1885 tons. It all came from England, and the price varied from £9 6s. 6d. in September, 1904, to £11 10s. per ton in January, 1907.

The rails are 85lb. flat foot British section. The sleepers are of Jarrah wood 9ft. by 10in. by 5in., spaced 14 to a 36ft. rail. The line is well ballasted throughout. There is one tunnel 1320ft. long built for a double line 26ft. 3in. wide at spring of arch and 27ft. 3in. at rail level, the height being 21ft. 3in. from rail to soffit. Distant and home signals are erected at all stations, and are controlled by levers from a locking frame in the station buildings. The interlocking system is complete. The carriages are all of British make, and are fitted with the usual conveniences. They are roomy and lighted by electricity, and have Westinghouse brakes. Some of the wagons are of German manufacture. All the locomotives, except one, are of British make.

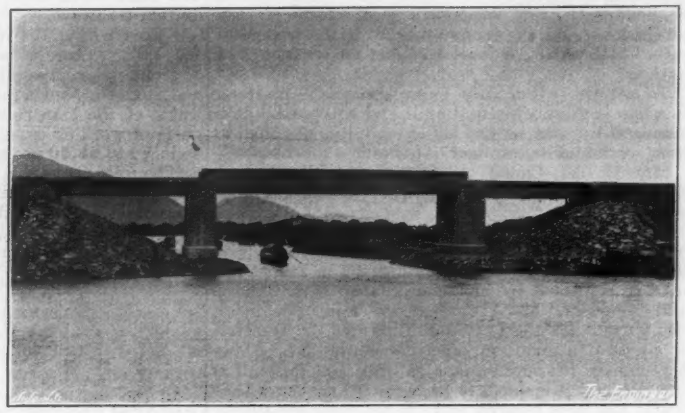
This line is greatly in need of more rolling stock. During my visit there was only one locomotive in the sheds, and that was under repair, and the wagon and carriage repair shops and sidings were entirely empty. Every available truck is kept running continually, and Mr. E. J. Dunstan, the locomotive superintendent, has an anxious and busy time. I was informed that orders have been made out for months for locomotives and carriages and wagons of something like £100,000 value, but no responsible firm would accept them because payment could only be made by instalments spread over a number of years, bearing interest of course. This is much to be regretted, as the line has just arrived at that critical position when a matter of this kind means success or failure. Incidentally this condition of things is indicative of the want of confidence felt by financiers and manufacturers in the Chinese Government. It seems almost incredible that an order of this kind should go begging and be returned unfilled. Any reliable maker might have had it when I was there at his own prices, within reason of course. The terms of payment could not have been the trouble, as the interest offered was sufficient

* No. II. appeared May 8th.

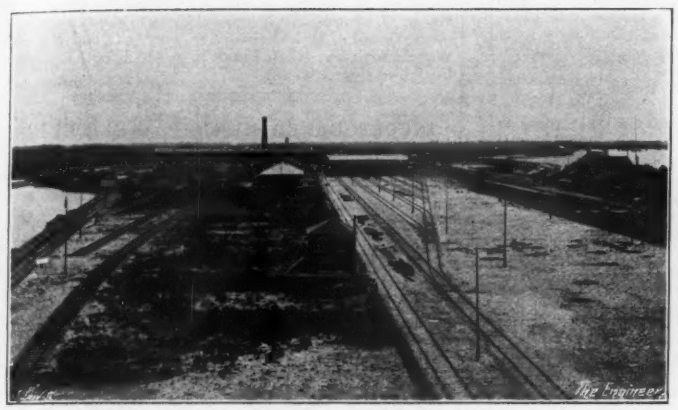
# THE SHANGHAI-NANKING RAILWAY

(For description see page 564)

SMALL CANAL BRIDGE

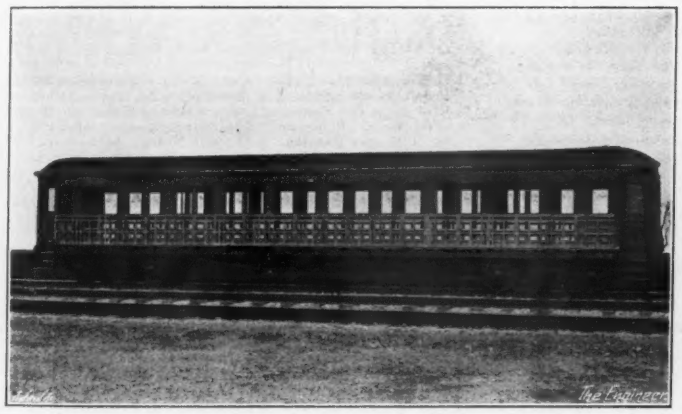


BRIDGE OVER THE GRAND CANAL OF CHINA



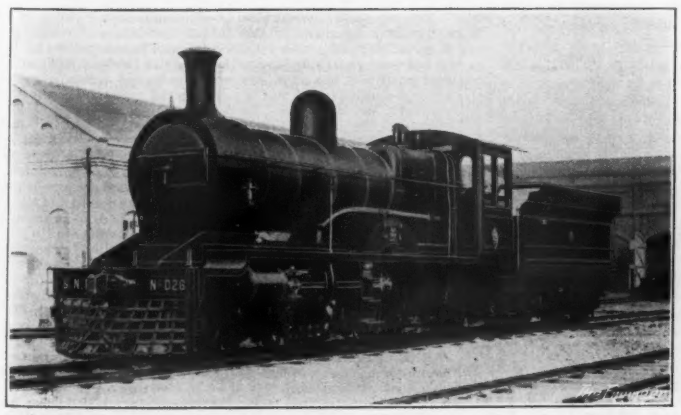
WORKSHOP AND YARD OF WOOSUNG

SHANGHAI STATION

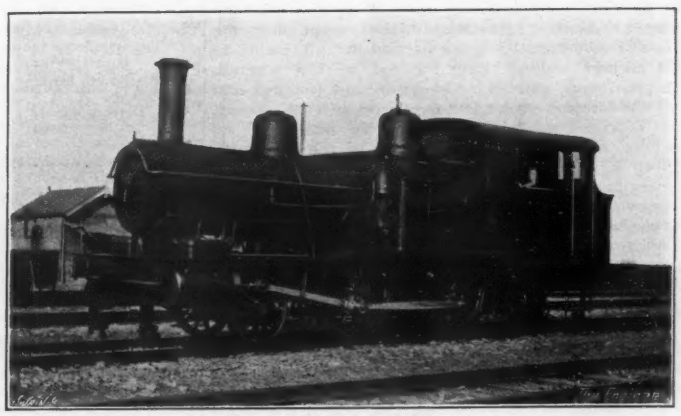


SLEEPING CAR UNDER CONSTRUCTION AT WOOSUNG

EXPRESS CORRIDOR TRAIN



SINGLE-DRIVER LOCOMOTIVE



AMERICAN LOCOMOTIVE FOR THE WOOSUNG BRANCH

to carry any account. The real trouble is that the credit of the Chinese Government has entirely vanished and the methods of those in high authority do not commend themselves to the commercial world. These things would be sufficient in themselves, but besides there is the general fear that political troubles are far from ended, and that the revolution is but the beginning of a long series of upheavals. The world is no believer in the permanent good effects of easy revolutions, and the money market is the best indicator of the world's unspoken dictum on men and nations.

To return to our own more immediate matters, this line is thoroughly well built and equipped. It is managed by men of the highest ability, devoted to their work and determined to make it a success.

Mr. M. Y. Chung, the managing director at Shanghai, impressed me as a man of much ability and of the highest integrity.

Mr. A. W. U. Pope, C.I.E., the general manager, has great experience and unlimited energy, which he devotes unstintingly to his work, and I have met few men so respected by his subordinates, both Chinese and foreigners. Mr. A. C. Clear, the resident engineer, has a thorough grasp of his duties, and Mr. Dunstan is an ideal locomotive superintendent. Everything that makes for success in a railway and its staff is present, and it is much to be regretted that now that traffic has been secured there is not sufficient rolling stock to cope with it.

The cost of construction of this line has been the subject of much adverse criticism. Some have put it as high as £15,000 per mile, but this seems unfair, as it would represent more than the whole face value of the sum raised. After going carefully into many figures and making due allowances for charges in connection with the service of the loan, it would appear that, including cost of land, the price now works out at about £11,250 per mile. At the date of opening it was considerably less. But even those who affect to be most indignant about the excessive cost, and hold it up as an example of British extravagance, allow that this is the best built and best equipped line in China. Besides, when the time comes for doubling the track it will be found that the expense of so doing will be comparatively small, owing to the forethought and provisional measures taken with this end in view.

Here, as in the case of the Kowloon-Canton line, there is severe competition by water. This traffic is so great that boat trains go several times a day—that is, a "launch" tows six or eight boats laden with passengers and goods. Personally my sympathies are with the boatmen, for it seems unkind that a Government should enter into competition with its subjects in such a matter. But, for good or ill, the line is built, and if possible it must be made to pay; this at least is the view taken by the general manager and his staff.

The boat fare for coolies between Shanghai and Soochow is 50 cents, or 1s. in English money, and the distance is 54 miles by rail. Besides being carried for this small sum, the coolies received two free meals. An attempt to meet this competition was made in 1907, when the rate of third-class fares was lowered to 1 cent per mile (equal to about ¼d.). At the same time there was a reduction made in the second and first-class fares, making them equivalent to about ¾d. and 1¼d. per mile. The result was a large increase of third-class passenger traffic, and at the same time a substantial increase in the earnings from this source. In the general manager's report for 1911 the following passage occurs. "The passenger traffic per mile open is double that of all the other railways in the East. The average figure for all the railways of India is 11,000 per mile, and on this railway it is 22,000." It may be said that this is a most exceptional and satisfactory result, and as the revenue from this source increased at the same time by 177,796 dols., and the train mile receipts by 26 per cent., the policy of low third-class fares seems amply justified.

In the matter of goods traffic the result is so far disappointing, and the total earning under this head is less than 11 per cent. of the whole. This is owing to trouble about the Likin tax—a tax imposed on goods in transit. The collection of likin is made by provincial officials who have wide discretionary powers. As it is calculated on the weight of goods, there is no escape for those carried by rail, owing to the correct weight being entered on the waybill, whereas goods carried by boats are not weighed and are the subject of crude calculation in this respect, and of consequent bargaining to the benefit of the owners, and also to the enriching of the collectors. There is, in short, no chance of likin "squeeze" on the railways. There is a strong movement against this system at present, and the result is expected to be the benefit of the railways.

The net result of 1911 was that the working expenses were 66.20 of the gross earnings, and that the net earnings were equal to 2.46 per cent. of the actual capital invested. The general charges are excessively high—the upkeep of two entirely separate departments (Chinese and British) where one would do as well, together with commissions in England and commissions in China, &c., account for a margin which would go far to putting this line in a position to show returns sufficient to pay its full interest of 5 per cent. on the capital employed.

Even with these drawbacks, 1912 will show again an improvement on 1911, and should the likin tax collection be adjusted to operate fairly 1915 should see the Shanghai-Nanking Railway independent of further Government support.

Mr. Pope has as his chief assistant Mr. Cooper, who was for eight years on the Indian State Railways. Mr. Middleton, chief accountant, is also from the Indian Railways.

Since writing the above I have seen the returns for 1912. There is an appreciable increase of net revenue as compared with 1911. This item now represents a sum equal to 3½ per cent. of the face value of the loan raised to build the railway. The ratio of working expenses to gross earnings has been reduced to 64.70 per cent.

The following table shows the progress made with reference to payment of interest on the capital embarked on the undertaking, viz., £2,900,000.

| Year. | Total of interest charges to be made up. (This varies on account of Exchange.) Dols. | Net earnings made by railway. Dols. | Annual loss to Chinese Government. Dols. |
|---|---|---|---|
| 1908 | 1,692,333 | 517,815 | 1,174,518 |
| 1909 | 1,662,635 | 581,567 | 1,081,068 |
| 1910 | 1,564,850 | 627,671 | 937,179 |
| 1911 | 1,548,056 | 760,886 | 787,170 |
| 1912 | 1,386,909 | 971,149 (*a*) | 415,760 (*b*) |

(*a*) This would have been 200,000 dols. better if the rolling stock asked for eighteen months ago had been supplied.
(*b*) This would have been 200,000 dols. less for the same reason.

I enclose some photographs, and also some interesting prints showing the mode adopted in China of conveying rules of working to coolies by a new set of hieroglyphics.

Mr. Dunston has given me the following particulars of some of his locomotives:—

*A Class*, 4–6–2 *Goods Tank.*

| | |
|---|---|
| Cylinder | 18in. diameter<br>26in. stroke |
| Heating surface— | |
| Tubes | 1467.39 sq. ft. |
| Fire-box | 162.61 sq. ft. |
| Total | 1630.00 sq. ft. |
| Fire-grate area | 28 sq. ft. |
| Tractive force taking 75 per cent. of boiler pressure | 19,951 lb. |
| Weights in working order— | |
| Bogie | 15.4 tons |
| Leading wheels | 15.7 tons |
| Driving wheels | 16.35 tons |
| Trailing wheels | 15.75 tons |
| Radial wheels | 11.15 tons |
| Bunker and tank capacity | 1¾ tons of coal<br>1120 gals. of water |

*B Class*, 4–6–0 *Goods Locomotive and Tender.*

| | |
|---|---|
| Cylinder | 18in. diameter<br>26in. stroke |
| Heating surface— | |
| Tubes | 1467.39 sq. ft. |
| Fire-box | 162.01 sq. ft. |
| Total | 1630.00 sq. ft. |
| Fire-grate area | 28 sq. ft. |
| Tractive force taking 75 per cent. of boiler pressure | 19,951 lb. |
| Weights in working order— | |
| Bogie | 13.95 tons |
| Leading wheels | 14.1 ,, |
| Driving wheels | 16.5 ,, |
| Trailing wheels | 15.75 ,, |
| Tender | 42.25 ,, |
| Tender capacity | 7 tons of coal<br>3500 gals. of water |

*C Class*, 4–4–0 *Passenger Locomotive and Tender.*

| | |
|---|---|
| Cylinder | 18in. diameter<br>26in. stroke |
| Heating surface— | |
| Tubes | 1467.39 sq. ft. |
| Fire-box | 162.61 sq. ft. |
| Total | 1630.00 sq. ft. |
| Fire-grate area | 28 sq. ft. |
| Tractive force taking 75 per cent. of boiler pressure | 17,260 lb. |
| Weights in working order— | |
| Bogie | 19.55 tons |
| Driving wheels | 18.95 ,, |
| Trailing wheels | 18.15 ,, |
| Tender | 41.7 ,, |
| Tender capacity | 7 tons of coal<br>3500 gals. of water |

*D Class*, 4–2–2 *Passenger Locomotive and Tender.*

| | |
|---|---|
| Cylinder | 18in. diameter<br>26in. stroke |
| Heating surface— | |
| Tubes | 1467.39 sq. ft. |
| Fire-box | 162.61 sq. ft. |
| Total | 1630.00 sq. ft. |
| Fire-grate area | 28 sq. ft. |
| Tractive force taking 75 per cent. of boiler pressure | 16,045 lb. |
| Weights in working order— | |
| Bogie | 19.9 tons |
| Driving wheels | 18.9 ,, |
| Trailing wheels | 17.25 ,, |
| Tender | 42.65 ,, |
| Tender capacity | 7 tons of coal<br>3500 gals. of water |

0–6–0 *Bagnall Engine.*

| | |
|---|---|
| Cylinder | 15in. diameter<br>20in. stroke |
| Heating surface— | |
| Tubes | 653.5 sq. ft. |
| Fire-box | 68.25 sq. ft. |
| Total | 721.75 sq. ft. |
| Fire-grate area | 14 sq. ft. |
| Tractive force taking 75 per cent. of boiler pressure | 12,558 lb. |
| Weights in working order— | |
| Leading wheels | 10 tons 18 cwt. 1 qr. |
| Driving wheels | 10 tons 18 cwt. 1 qr. |
| Trailing wheels | 10 tons 13 cwt. 2 qr. |
| Bunker and tank capacity | 1½ tons of coal<br>780 gals. of water |

2–4–2 *American Engine.*

| | |
|---|---|
| Cylinder | 16½in. diameter<br>23½in. stroke |
| Weights in working order— | |
| Front truck wheels | 12.19 tons |
| Driving wheels | 13.3 ,, |
| Trailing wheels | 13.3 ,, |
| Rear truck wheels | 11.2 ,, |
| Bunker and tank capacity | 2 tons of coal<br>1000 gals. of water |

Reproductions of some photographs of rolling stock and pictures taken on the line, are given on page 565, and one of the diagrams of the kind that is circulated amongst the coolies to instruct them in their duties is reproduced on page 564.

## SMOKE AND NOXIOUS VAPOURS.

THE Departmental Committee appointed by the President of the Local Government Board "to consider the present state of the law with regard to the pollution of air by smoke and other noxious vapours, and its administration, and to advise what steps are desirable and practicable with a view to diminishing the evils still arising from such pollution," met for the first time on Tuesday last, when it decided that its meeting should be open to the public. It again met on Wednesday and Thursday, and then adjourned till June 10th and 11th.

The Committee consists of the Right Hon. Russell Rea (chairman); Mr. H. Brevitt, Town Clerk of Wolverhampton; Professor J. B. Cohen, Professor of Chemistry at Leeds University; Colonel H. Hughes; Mr. J. F. MacCabe, Inspector under the Local Government Board for Ireland; Lord Newton; Captain H. R. Sankey; Mr. B. Duncomb Sells, general manager of the Machinery Users Association; Mr. P. C. Simmons, member of the London County Council; Mr. E. D. Simon, of Manchester; Bailie W. B. Smith, member of the Glasgow Corporation; Mr. H. O. Stutchbury, Principal Clerk of the Local Government Board; Mr. Christopher Turnor; and Sir Aston Webb; with Mr. E. A. Faunch, of the Local Government Board, as Secretary.

## INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

THE following programme has been issued for the nineteenth annual convention, to be held at Birmingham, June 15th to 20th:—

*Tuesday, June 16th.*—10 a.m.: Opening of the Convention at the Large Theatre, Midland Institute; official welcome by the Right Hon. the Lord Mayor, Lieut.-Colonel Ernest Martineau. Paper on "The Commerical Development of Electrical Supply in Towns of Moderate Size," by Mr. W. A. Vignoles. 2.30 p.m.: Conveyances leave the Grand Hotel for visits to the works of the General Electric Company, Limited, at Witton. The party will afterwards proceed to the works of Belliss and Morcom, Limited, Birmingham. The Corporation electric generating station, Summer-lane, will also be open for inspection. 7 p.m.: Annual dinner at the Grand Hotel.

*Wednesday, June 17th.*—9.15 a.m.: Special train leaves New-street Station, Birmingham. 10 a.m.: Meeting at St. Mary's Hall, Coventry. Paper on "The Design and Operation of Modern Boiler-house Plant," by Mr. S. E. Fedden. 2.30 p.m.: Visits to Coventry Corporation electricity works and the Daimler Company's works. The following works will also be open for inspection:—Coventry Ordnance, Triumph Motor Cycle Works, Coventry Chain Company, B.T.H. Company's meter works; the British Thomson-Houston Company and Messrs. Willans and Robinson, Rugby, will convey any members who desire to see their works to Rugby and back to Coventry during the afternoon. 8.30 p.m.: Reception and dance by invitation of the Lord Mayor and Lady Mayoress at the Council House, Birmingham.

*Thursday, June 18th.*—9 a.m.: Motor vehicles leave the Grand Hotel, Birmingham, for Stratford-upon-Avon. 10.30 a.m.: Meeting at the Memorial Lecture Room, Waterside, Stratford-upon-Avon. Paper on "The Standardisation of Tariffs," by Mr. J. Horace Bowden. 2.30 p.m.: Motor vehicles leave Bridge-street for Warwick, where a stop will be made to inspect the Castle and grounds. 5 p.m.: Motor vehicles leave the Castle for Birmingham *vid* Kenilworth, where the party will be able to see the ruins as they drive past. 8.30 p.m.: Conveyances leave the Grand, Midland and Queen's Hotels for an open-air *fête* and concert, in the grounds of the Botanical Gardens, Edgbaston, by the invitation of the Birmingham Entertainments Committee.

*Friday, June 19th.*—9.30 a.m.: Council meeting at the office of the Secretary of the Midland Institute. 10 a.m.: Annual general meeting at the Large Theatre of the Midland Institute. 2.30 p.m.: Visit to the Corporation electric generating station, Summer-lane. 8 p.m.: Cinderella dance at the Grand Hotel, by invitation of the Birmingham Entertainments Committee.

*Saturday, June 20th.*—8.40 a.m. Train leaves New-street Station, due at Worcester (Shrubhill) at 9.40 a.m. 10 a.m.: Assemble at Guildhall. Alternative visits to the Royal Porcelain Works, the Cathedral, and the Commandery. 11.30 a.m.: Motor vehicles leave Edgar-street for a visit to the water power station, at Powick, to inspect the low-pressure turbine; afterwards the party will proceed by motor vehicles for a drive round the Malvern Hills. 3.48 p.m.: Train leaves Shrubhill Station.

MANCHESTER ASSOCIATION OF ENGINEERS.—A party of over a hundred members of this Society, with the President, Mr. E. G. Hiller, paid a visit of inspection on Thursday, the 14th inst., to the works of Rolls-Royce, Limited, at Derby. Split up into parties of ten, the members were conducted around the works by representatives of the firm under the guidance of the works manager, Mr. Wormald. As the works now cover some 19 acres of ground, finding employment for a staff of 200 and 1600 workpeople, who turn out over 700 chassis per year, it will be gathered that the 2½ hours allowed for inspection purposes were very fully occupied, and that the visit was greatly appreciated by those present. Many would gladly have made their visit much more lengthy in duration. The members were conducted through the foundry for brass and aluminium, and had an opportunity of witnessing the casting of gear boxes and crank cases in aluminium. Then the pattern-shop, spring-making department, stores, fitting, machine and erecting and testing departments were all inspected. Particular interest was taken in the gear-cutting and grinding departments, which are equipped with all the latest machines for producing the supreme finish of the parts, for which this firm's cars are held in such high repute. The drawing and commercial offices afforded the members a chance of obtaining an insight into the splendid organisation which is a conspicuous feature of the works, while several members availed themselves of the chance of a seat on cars which were being put through their early trials on the firm's own testing track. At tea, which was served at the Midland Hotel after the visit, a vote of thanks to Rolls-Royce, Limited, for their kindness in allowing the visit was passed.

## RAILWAY MATTERS.

THE provision of speed recorders to American locomotives has not as yet been adopted universally, but the Baltimore and Ohio Railroad has equipped most of its engines for fast running with them.

DURING the three months ended September 30th last there were, according to the Inter-State Commerce Commission's *Accident Bulletin*, 211 passengers killed and 4011 injured in train accidents in the United States. There were 173 collisions and 223 derailments, in which passenger trains were concerned. Defective equipment and defective roadway accounted for 67.6 per cent. of the derailments.

IN view of the antagonistic attitude of the tribesmen in Western Persia, the Government has granted to the British syndicate for the construction of the railway from Mohammerah to Khoramabad an extension of its concession for eighteen months from the time when the state of the country permits of the resumption of the survey. The Persian Government has also intimated its willingness to negotiate with the syndicate for the actual construction of the first half of the line from Mohammerah to Dizful, to which point the survey has been completed.

THE Board of Trade has recently confirmed the undermentioned order made by the Light Railway Commissioners:—North Staffordshire Railway (Trentham, Newcastle-under-Lyme and Silverdale Light Railways) Order, 1914, authorising the construction of light railways in the county of Stafford, from Trentham to Newcastle-under-Lyme and Silverdale, with the reconstruction and working of certain branch railways of the North Staffordshire Railway Company as light railways under the Light Railways Acts, 1896 and 1912, and for other purposes.

GREAT improvements have been effected in escalators since they were first introduced. One beneficial change lies in making them reversible, so that should an ascending escalator fail, the descending one can be reversed and used for taking passengers up. Passengers going down would then walk down by the one ordinarily used for ascending, as it would then be stationary and like ordinary stairs. The latest improvement is the provision of stops to hold the escalators in case of a failure. Switches are also provided for the attendants to press and stop the machinery in case of emergency.

IN the course of a discussion in the Dover Council on the rates to be charged by the Electricity Department to the Tramways Department for current used by the tramways, it was stated, according to *Electrical Engineering*, that the use of meters on the cars had led to such economy in current consumption that the total amount was reduced below the figure at which a reduced charge per unit was made, and therefore energy was charged for at 2¾d. per unit, instead of 2½d. which had been the charge during previous years, when, without meters, the consumption was greater. A motion to charge at the 2½d. rate was defeated.

AMONGST the many proposals in connection with Russian railways, the new inter-terminal line at St. Petersburg is of particular interest. This line will form a circular railway connecting up the various lines entering the city, and, besides being available for carriage of merchandise and passengers from one system to another, will serve the new port as well as a number of factories in the St. Petersburg suburbs and thus facilitate transport. It should also attract a heavy local passenger traffic. The line will be about 63 miles in length. No decision has yet been come to with regard to the equipment of this line, but there is some talk of its being worked electrically from the first, as it will eventually, owing to traffic considerations, have to be made an electric railway. The chief impediment to electric working is the complication at its junctions with the other railway systems.

ON September 8th last a passenger train was derailed, and a passenger killed, at Donemana, on the County Donegal section of the Midland Railway, Northern Counties Committee. Owing to the driver having been sentenced to four months' imprisonment and having appealed, Major Pringle's report has only just been issued. The report is a long one, and most uninteresting, but the purport of it was that the driver was the worse for drink, and evidently thought he was a station further on his journey than he was. Instead of having 3¼ miles to go up a rising gradient, he had but two miles on a falling gradient. He travelled at a high rate of speed, and in passing through the facing points of the loop at Donemana the whole train was derailed, the engine and first two carriages being overturned. The day was Sunday, and the driver, fireman and guard, who belonged to Strabane, had to remain in Londonderry from 9.45 a.m. to 8.45 p.m. doing nothing, a state of affairs which Major Pringle considers should be altered.

ACCORDING to the *Railway Gazette*, one of the leading American railways recently sent a train over an extensive part of its system for the special purpose of collecting together all the scrap material and odds and ends of every kind which could possibly be got together, the train being accompanied by a divisional superintendent and his entire staff. In addition to the collection of scrap, the party was organised so that each officer made a close inspection of all work under his supervision at each station, and all bridges and buildings were inspected, accounts were examined, and, generally speaking, inspection on a large scale carried out. The quantity of scrap and obsolete material gathered on the trip amounted to 147 wagon loads, valued at £8366 13s., the cost for labour, expenses of the train, including meals, amounted to £452 10s. 7d., leaving a net gain of £7913 18s. In addition, surplus tools, valued at £574 19s., were transferred from sections were they were not needed to other sections. As an illustration of the conditions encountered, twelve bottles of ink were found at one small station where one bottle is sufficient for nearly a year, whilst at another point fifty non-insulated bridle rods were found at a station on territory which was track-circuited throughout. Useless there, they were serviceable elsewhere. Apart from the savings in scrap recovered, this trip was considered a success because of the opportunity it further afforded for the officers of each department to come into contact with the men of that department over the entire division.

## NOTES AND MEMORANDA.

A NEW electrical process for extracting benzine from coal has recently been invented by a Swedish engineer, Mr. Vidstrand, of Stockholm; the costs of manufacture are said to be considerably lower than those of the methods now employed. The product is stated to be as good as any other fuel for motor cars. The process has been patented in eighteen countries, and the inventor is carrying on negotiations with a group of Norwegian financiers with the view of disposing of the patent rights for Norway. It is the intention to form a company for the purpose of erecting a large manufactory in a suitable place, where sufficient energy is available for carrying on the manufacture on a large scale.

ARISING out of the question directed the other day in the House of Commons to the Home Secretary on the suitability of monarkite as a permitted explosive, a series of interesting demonstrations and tests have just been carried out in some of the more important collieries throughout Lanarkshire. The parties present at the demonstrations were in general agreement with the results obtained, the consensus of opinion being that in particularly hard brushing roads the explosive had performed singularly effective work. On the question of fumes, it was conceded, notwithstanding the severity of the tests, and the fact that in some instances the full charge limit was used, that there was little if anything to compain of.

THE first good results in Germany in the way of using water gas in steel works are those which have been achieved by the Torgauer Company, at Torgau. The company, which was started in 1910, is working a 15-ton basic furnace producing steel for casting purposes by this means. The gas-producing plant is of the Dellwik-Fleischer type, and comprises two producers having a capacity of from 26,500 to 35,300 cubic feet per hour. The plant is operated by one workman with the assistance of a labourer, who also looks after the stoking. Blast furnace coke is generally used, but practically as good results are obtained with gas coke. On the average, 460 cubic feet of gas per minute are consumed, which for an output of, say, 14 tons, and a total time of five hours, equals a fuel consumption of 14 per cent., taking 70 cubic feet of gas as being obtained from 1 kilo. (2.2 lb.) of coke.

THE flow of sand and other fine materials through openings of various shapes and in different circumstances is not a subject which has received much attention from experimentalists. From a paper by Professor Hersam in the April number of the *Journal* of the Franklin Institute, we gather that the following are his principal results. The velocity of flow is determined mainly by the size of the particles and of the opening, but is slightly diminished by angularity of the particles or by moisture on them. The specific gravity of the particles, the height of the material above the opening, and the shape of the upper contour of the material have little effect. If D is the diameter of the opening, $d$ that of the particles, both in inches, the mean velocity of flow V in feet per second is given with sufficient accuracy for most practical purposes by the equation, $V = (D - 2d)/\sqrt{D}$.

AFTER working some considerable time, a large crankshaft fractured through an arm of the crank connected with the high-pressure cylinder. The material contained 0.23 per cent. C, 0.94 per cent. Mn, 0.06 per cent. S, and 0.06 per cent. P; had a tensile strength of about 27 tons per square inch, and an elastic modulus of 30 $\times 10^6$ lb. Under shock tests it showed up badly, and its microstructure indicated that it had been overheated. From the indicator diagrams and the weights of the moving parts the stresses existing in the crank shaft were calculated. The results show that the stresses were not high enough to account for fracture, assuming that the engine had been properly assembled when new. The positions of the bearings, however, had not been happily chosen, which would give rise to greatly increased stresses after wear had taken place, *e.g.*, a wear of 3 mm. on the end—fly-wheel—bearing would just about double the stress on the crank arm which ultimately fractured.

IN renewing rails, the labour problem is often a serious factor, owing to the large number of men required to handle heavy rails. A rail-handling machine for picking up the new rails and setting them in position is now in use. The machine is a hand crane, having a pair of double flanged wheels to ride upon one rail while the inclined boom is supported by an A frame resting on the sleepers. The sill of this A frame may be fitted with a pair of pivoted or removable axles carrying small flat-tired wheels to ride on the opposite rail. When the machine is to be moved forward, these wheels can be quickly replaced. The weight is transferred entirely to the one rail by pressing down on a counterweight bar so as to raise the A frame clear of the ties. Then the extra wheels can be adjusted, or the machine can be pushed forward while balanced on one rail. The winding drum carries a chain of such length that rails 14ft. from the line can be reached. Three men are required to operate the machine. The three men can lay 100 lb. rails at the rate of three per minute.

IN a paper read in America some little time back, Mr. F. W. Peek gives a valuable *résumé* of recent advances in the science of high-voltage engineering. The results show that the corona effects and dielectric losses can now be predicted with high accuracy. When testing solid dielectrics the importance of taking time into account is emphasised. Laminated insulation is much better than solid insulation, as it is very improbable that weak spots "line up" when the insulator is laminated. It also makes the dielectric more uniform. The "energy distances" are also limited by the laminations and the apparent strength is increased for this reason. On account of the very great energy loss at continuous high frequency the insulation may be burned up in a very short time, even at low voltages. A discussion is given of the methods of grading dielectrics so as to increase their electric strength. The effect of altitude on the "spark over" voltage is also considered. In the author's opinion the probable limit of voltage for power purposes in America is 200,000 volts. This follows from economical considerations, but except at high altitudes a quarter of a million volts may be used without unduly increasing the diameter or spacing of the conductors. At present the line insulator is a much more serious difficulty than the corona.

## MISCELLANEA.

IT was announced at the meeting of the London County Council on Tuesday that the new proposals for London's electricity supply would be ready to be brought before Parliament next session.

THE Sixth International Congress of Mining, Metallurgy, Engineering and Economic Geology will be held in London in 1915. Further particulars may be obtained from Mr. G. C. Lloyd, General Secretary of the International Congress, 1915, 28, Victoria-street, London, S.W.

ACCORDING to a census taken by *Motor Traction*, and published in that journal for May 9th, 58–85 per cent. of the traffic passing through Fleet-street is of the self-propelled type, whilst the number of horse-drawn vehicles has dwindled from 86.78 per cent. in 1907 to 41.15 per cent. in 1914.

IT has been resolved by the Executive Council of the South Wales Miners' Federation to protest against the action of the Committee of the Miners' Federation of Great Britain in accepting the Home Secretary's new Mines Bill, and to insist on more drastic proposals for safety in collieries.

THE reconstruction of Greenwich Pier being now complete, the structure will be declared open by the Chairman of the Highways Committee of the London County Council, Mr. G. H. Hume, on the 27th inst., at noon. The Chairman will afterwards start the first of the new 8000-kilowatt turbines at the Greenwich generating station.

THE Home Secretary gives notice that at the expiration of forty days from May 12th he will make regulations to apply to factories and workshops in which articles wholly or partly made of celluloid are manufactured or stored. Copies of the draft regulations can be obtained from H.M. Chief Inspector of Factories, Home-office, London.

THE first exhibition of motor-cycles, organised by the *Gazzetta dello Sport*, was opened at Milan on April 30th, under the auspices of the Motor-cycle Club of Italy and the Italian Touring Club. The show also comprised the exhibits of twenty-four English, ten Italian, four German, four French, two Belgian, one Rumanian and one American firm. The exhibition remained open until yesterday.

MOST of the fire-engines and escapes in Berlin are horse-drawn, but it has recently been decided to replace them as rapidly as possible by accumulator vehicles. Fire-engines intended for long journeys will have a petrol engine both for propulsion and for pumping, but those for city use only will be driven by accumulators; the latter will, however, each have a petrol engine to drive the pump, and a dynamo will also be coupled to the engine, so that in emergencies the battery of the vehicle itself and of electrically driven escapes, &c., can be charged at the scene of the fire.

ACCORDING to the *Chemical Trades Journal and Chemical Engineer*, an ingenious analytical method for estimating substances susceptible of precipitation from liquids has been invented by M. Diénert, the chief engineer of the City of Paris water supply, by combining the calorimetric process of Dubosc with the projection lantern. By comparing in the two halves of the field a liquid containing matter in suspension and a standard liquid, it is easy to see if the colouration is the same. The method is applied to the estimation of matters contained in natural waters, and only requires 20 to 30 cubic centimetres of water for each analysis. It is stated to be as exact as the usual methods.

THOUGH established only a year, the Nottingham electrical hospital has abundantly justified its existence, and an excellent record of work was reported at the annual meeting last week. Dr. Bolton, hon. medical officer, stated that Nottingham was the pioneer city in establishing such a hospital for the poor. Since the date of the opening, 260 patients had presented themselves for advice or treatment, and many of them were deeply grateful for the benefit received. The less chronic the disease the better had the results been. Many of the patients expected apparently to be cured by electricity at one sitting, or at most by five or six treatments, and failing in this, they ceased to attend. This was much to be regretted, for electricity would produce excellent results only on those who persevered in the treatment.

A LECTURE on the "Electric Driving of Textile Machinery" was delivered recently by Mr. J. F. Crowley at Galashiels to an audience of Border woollen manufacturers, mill engineers and others. He emphasised the advantages of electrical driving in doing away with quantities of shafting and permitting more economical transmission and arrangement of machinery under steadier speed, enabling increased output to be obtained. He discussed the relative merits of group and individual drive. Although he did not recommend individual driving for every department of a mill, he put a strong case for individual loom drive, and claimed that the production of a weaving shed could be increased as much as 30 per cent. by their adoption. He spoke of a case at Bolton where the electrical equipment had paid for itself in nine months by increased production.

A MEETING of the Electric Vehicle Committee was held at the Institution of Electrical Engineers on April 24th, Mr. R. A. Chattock presiding. Mr. E. W. Curtis, jun., vice-president of the General Vehicle Company, of Long Island, United States of America, was elected a member during his stay in England. It was also decided to invite Mr. Beauchamp, the engineer and manager of the West Ham Corporation electric supply undertaking, and Mr. K. Bowon, director of the Cedes Electric Traction Company, Limited, to become members of the Committee. As to the recent recommendation of the Committee regarding electric supply tariffs for battery charging, it was reported that a number of undertakings had already signified their decision to come into line with the suggested tariffs. A suggestion had been received from Mr. Warrilow for a demonstration of electric vehicles in Birmingham, on the occasion of the Incorporated Municipal Electrical Association's convention in June, and it was resolved to recommend to the Council of the Incorporated Municipal Electrical Association that arrangements be made for this purpose.

# A NEW SINGLE-PHASE RAILWAY IN THE UPPER RHINE DISTRICT

(*For description see page 555*)

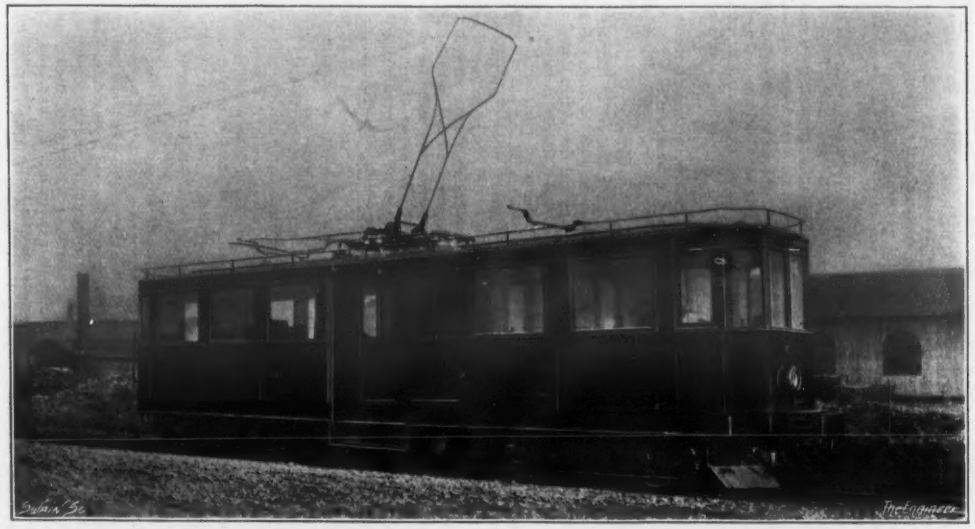


Fig. 13—MOTOR COACH

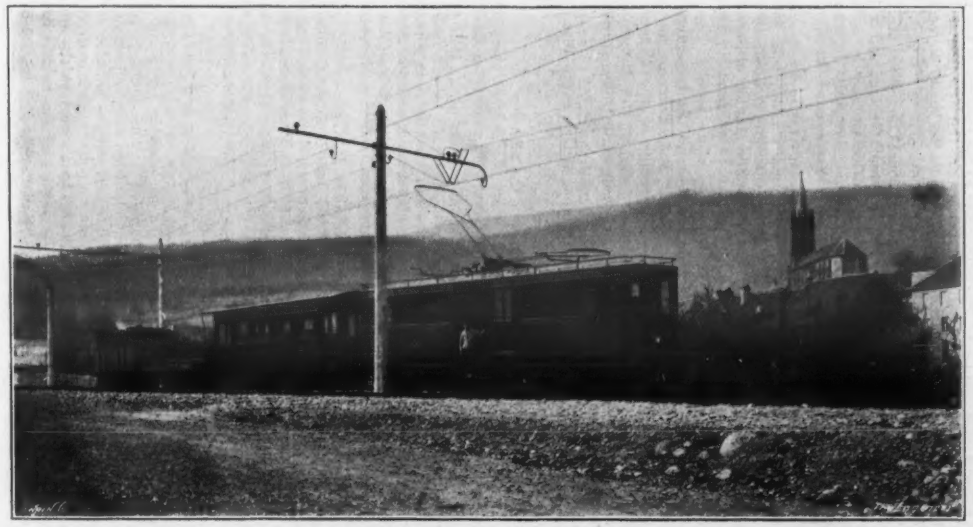


Fig. 14—TRAIN WITH MOTOR COACH AND TRUCKS

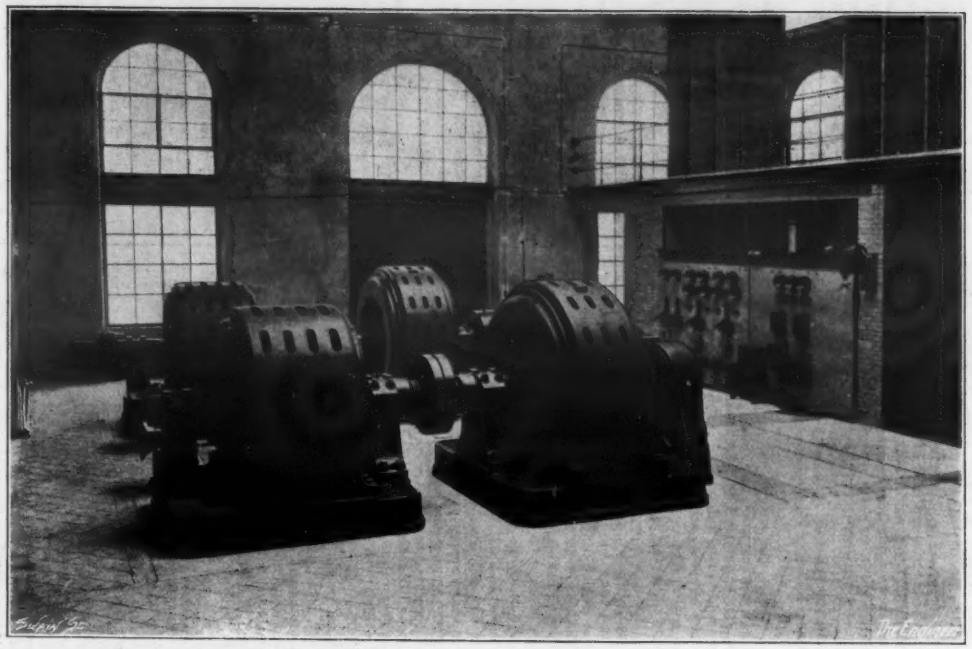


Fig. 15—SUB-STATION AT LA FORGE

Fig. 16—SUB-STATION SHOWING TRANSFORMERS AND SWITCHES

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## DEATH.

On the 17th inst., in his 64th year, at 13, Elsworthy-road, London, N.W., FRANCIS JAMES TREWEEK, M. Inst. C.E., M.I.N.A., &c., only son of the late Francis Treweek, of Neyland, Pembrokeshire.

# THE ENGINEER.

*MAY 22, 1914.*

### Alcohol as Fuel.

THE Alcohol Motor Fuel Committee of the Royal Automobile Club, to the constitution of which we referred some time ago, has already held several more or less informal meetings, and has decided, on broad grounds, the line which it is to follow in its investigations and the cost of the work it has in view. It has been happy enough to secure the whole services of Lieut.-Col. Sir Charles Bedford, whose experience with excise questions for many years in India cannot fail to be of the greatest value to the Committee, and it was with great pleasure we listened, at a luncheon given by the Hon. Arthur Stanley and the Committee at the Automobile Club on Wednesday last, to his opinions and those of Sir Boverton Redwood and Dr. Ormandy.

The question of the future of alcohol as a fuel may be divided broadly into two parts, the first the suitability of the fuel and the second the excise difficulties in the path of its adoption. Of the first we may say, with but little hesitation, that alcohol can be used with entire success in internal combustion engines. Experiments in France, Germany, and America, as well as in this country, have shown conclusively that it is not only a possible fuel, but a good fuel, and the fears which long exercised the minds of engineers and chemists that serious corrosion of the valves and cylinders of engines using it would occur have long since been dispelled. With a suitable denaturant nothing is to be feared in that direction. To get the best effects the engine and carburetter should be designed for the use of alcohol, just as at present they are designed for the use of petrol, but nearly all engines will work with little modification on methylated spirits as well as they will on benzole—indeed, in stress of circumstances cars before now have been run on whisky. With regard, then, to the technical questions we do not think the Committee will find any very formidable obstacles to overcome, and that part of the task at least should be safely accomplished within the five years that Sir Charles Bedford deemed necessary, and with a far less expenditure than the £6000 a year at which he estimated the expenses of the Committee. The excise problem is, in our belief, one of far greater magnitude. In no country is the production of alcohol watched with a closer eye than in this country, and we know from past experience that the Government is exceedingly chary about permitting any modification of its regulations. The first problem is to find a denaturant which will satisfy at the same time the excise officers and the engine maker. When that has been accomplished, and it is a great satisfaction to know that Sir Charles Bedford, whose experience on the subject is unsurpassed, is satisfied that it can be compassed, the next step is to modify existing regulations in such a manner that *ad hoc* factories for the manufacture of fuel alcohol can be established on terms and under conditions which will attract the capitalist. On this point the Committee must of necessity look for the help of public opinion. Government will not move an inch under the pressure of the Committee, powerful as it is, alone, and it must be supported by incontrovertible evidence that the country would benefit in no small degree by the use of fuel alcohol in internal combustion engines. On this point we are, ourselves, in no doubt whatever. Our internal resources for the production of fuels from shale and coal are comparatively small, very far indeed from being equal to our requirements. At the moment even the world's supply of oil fuel is insufficient to meet the demand, and prices have risen enormously in consequence. The probability that the mineral oils will ever fall in price again is remote. For certain purposes they must be used—the firing of marine boilers, for example—but for others we have a possible, and an excellent, substitute in alcohol, a fuel which can be produced in any country at a lower price than mineral oils can be imported. And not only produced, but produced at an advantage to the country, because it can be as well made from damaged as from the best raw material. The manufacture therefore offers tremendous advantages, and we do not hesitate to say that the future will look with surprise on the blindness and indifference with which we treated a fuel that lay under our hands whilst we were struggling against the ever-increasing price of a fuel we imported.

The Committee estimates that £30,000 must be spent in bringing its crusade to fruition. The sum is in appearance great, but it is absolutely trifling in comparison with the object to be attained. We are now dependent very largely upon extra-imperial supplies of oil; if the duty on fuel alcohol is so abated, and if the restrictions on its manufacture are so modified that capitalists here, and in our Colonies, can be tempted to lay down the plant for its manufacture, there can be no question that, in respect of the fuel it requires not only for its ever-increasing motor traffic requirements, but for many other industries as well, the empire can be made wholly independent. That is an object well worth striving for, apart altogether from the more direct appeal that must be made to hundreds of thousands of people in this country by the fact that their motor fuel bill will be decreased. We note with pleasure that the Committee is composed of a strong and representative body of men, and wish it every success in an object that we have had always at heart.

### The Coming Decline in the Shipbuilding Trade.

THERE are many signs that the general prosperity which has been such a distinguishing feature of the shipbuilding and engineering trade during the last three or four years is about to receive a somewhat serious check before long, and many and varied are the opinions of those who are attempting to estimate the extent or probable duration of the reaction. In fact, even though the date of its unfortunately certain advent is still the subject of much discussion, the unanimity with which its probable early arrival is regarded is distinctly depressing. Trade booms are by no means an unmixed blessing. Prosperity after depression may be delightful, but a more ideal state of affairs would be attained if it were possible to cut a little off the peaks of the prosperity side of the curve of output to fill in the gaps on the side below the normal line of trade. For very obvious reasons such a state of affairs is unobtainable, but it may serve a useful purpose to consider at the present time why the decline in shipbuilding should be approaching and how long it may last.

In the first place, it may confidently be said that there is no probability of a sudden reversal of existing trading conditions, but there is a slackening off in the iron and steel trade which is generally regarded as constituting an almost infallible barometer of the state of commercial conditions. Only six or seven years ago the freight market was in an appalling condition, and the quantity of tonnage laid up became truly phenomenal. As matters stand to-day, the intervening freight boom has come to an end and shipowners during the ensuing year or two will not only have to put up with lower rates, but also there is, unfortunately, on all sides a considerable prospect of a large reduction in the quantity of cargo to be carried. The recent boom really began in 1911, and for nearly two years there was a gradual rise in rates, but in the near future there is every likelihood of conditions reverting almost to those of 1908, when, in the Tyne alone, there were over one hundred cargo steamers laid up between Elswick and Jarrow. Quite a variety of causes have conspired to create depression in the carrying trade. The quantity of new tonnage ordered after the 1908 depression was very great, and served to keep shipbuilders busier than they have probably ever been before, but its effect on freight was soon apparent. Orders for manufactured steel in the form of rails or structural work for Argentina and Brazil have fallen off; the export of coal has been checked; and financial depression is existing abroad to a considerably greater extent than might have been anticipated after the last three years of trade. Except for the annual quantity of new naval construction which has, unfortunately, greatly decreased in the last three years, shipbuilders have to rely almost entirely on the prosperity of shipowners, and the conditions with which the latter have to contend are invariably reflected in the shipbuilding trade after a few months. The shipping boom of 1912 and 1913 has come to an end, and the

fact has been elaborately emphasised at more than one of the big shipbuilding companies' annual general meetings within the last few weeks. Only two or three weeks ago Mr. A. A. Booth, the chairman of the Cunard Steamship Company, frankly told the shareholders that with the increased earnings of their fleet during the past twelve months the directors might have felt justified in recommending a higher dividend but for the adverse factors with which they appeared to be faced in the coming year. The principal factors are interesting, as they show exactly in what position other of the Atlantic lines besides the Cunard Company will be placed. Emigration to Canada will certainly show a great diminution this year compared with recent years, while as far as can be estimated emigration to the United States will be on a smaller scale than last year, and Mr. Booth's opinion was that as a whole the volume of trade on the North Atlantic would not keep pace with the increased amount of tonnage available. Again, the reduction in quantity of cargo to be carried is accompanied by a reduction in rates. Competition in the North Atlantic seems quite unable to avoid reaching a constantly recurring state where rate cutting becomes ruinous. The difficulties in arriving at an agreement between the North Atlantic shipping companies has not yet been overcome, and further rate wars, both for the continental third-class traffic and in the British and Scandinavian third class, and conceivably even in the first and second-class business, seem not unlikely unless matters can be adjusted to the satisfaction of the parties concerned. The South American trade, too, like all others, is subject to constant violent fluctuations, and the swing of the pendulum in this part of the world is merely reflective of the condition in others. At the present time, although it is not necessarily very acute, the financial crisis in South America, especially as regards Argentina and Brazil, whose combined sea-borne trade with this country annually approximates a total of some £70,000,000, is affecting both the passenger and cargo traffic very considerably. Naturally this present depression in both countries may be regarded as merely temporary. Both are enormously wealthy, but neither possesses manufacturing facilities of its own; in other words, they are entirely dependent on the outside world for the supply of all the necessaries of life, and these the scale of living has forced up to a standard of great expense. Consequently, for the moment the overspending in the Argentine Republic and the heavy fall in the prices of rubber and coffee, which form the staple products of Brazil, have resulted in considerable trade slackness, which has further had its effect on the importation of coal. Naturally this depression, which is typical of that existing elsewhere, in Japan, for instance, is only temporary, and a country like Brazil will have no difficulty in restoring her finances to their accustomed order when trade will no doubt readily respond. But meanwhile the shipbuilding trade has to face a period of relative slackness. It seems likely that some months will elapse before this begins to be very seriously felt, because most of the yards throughout the country are replete with work for the time being, although there is a distinct falling off in the quantity of new work in prospect. Even so, it is not yet serious, because, although the tonnage return of work in hand was officially returned by Lloyd's as being 66,000 less for the quarter ending March 31st than for that ending December 31st, and as much as 173,000 less than for the corresponding quarter of last year, it must be remembered that the tonnage turned out last year by shipyards in this country reached a record figure.

The probable date of the advent of the depression is very hard to estimate. Quite a number of shipbuilders are inclined to believe that it may not set in for perhaps twelve months, as there is still a fair number of prospective orders in view although most shipowners have for the moment ample tonnage and no inclination to pay high prices for more, in view of the low rates obtainable. At the moment there is every prospect of at least two foreign battleships of exceptional size being ordered in this country, which will certainly assist in keeping up the money in circulation for naval construction, and it also appears probable that the cross-Channel companies may considerably increase their fleets, as the passenger traffic between England and the Continent shows every indication of enormous development in the future. Vessels, however, of such special types go a very small way towards augmenting the tonnage returns, although *per se* they are relatively costly. The reason why depression, which may perhaps be expected to become most acute in about eighteen months or two years, follows so suddenly on the boom of 1913 is really to be found in over-production, a fact which may be readily gauged by taking the current price of ship plates, which is now some £6 per ton, compared with the £8 5s. which ruled at this time last year. It is justifiable to wonder whether the capabilities for production at the present time are not considerably in excess of the requirements. On the other hand, the inevitable tendency towards the expansion in trade which must follow from the development of countries like Canada, Brazil, or British Central Africa, cannot fail to be one of lessening the duration of these periods of depression, and we are quite unlikely to be faced with such lengthy and disheartening depressions of the shipbuilding trade as those that existed towards the end of last century. If the occasion of the last depression in 1909, when the year's output fell below that of the average of the previous twelve years or more, is any guide, the gloomy forecasts made in some quarters of the coming decline will be materially alleviated by a similar rapid recovery.

### The Split Phase System.

IT is pretty clear from recent articles in American technical journals that American manufacturers are not satisfied with their single-phase traction motors. The motor has always been the weakest link in the single-phase system; it has exercised the brains of some of the most able electricians for years, and its development has involved much experimental work and the outlay of much money. Some have tried to improve single-phase motors, whilst others have invented schemes for eliminating them altogether. Mr. Ward Leonard in the year 1891 was granted a patent under which he proposed to feed with single-phase current a synchronous motor mounted on the locomotive, and this motor was to drive a dynamo generating direct current for the driving motors. Messrs. Mordey and Jenkins, in a paper read before the Institution of Civil Engineers in 1902, suggested the use of an induction motor in place of the synchronous machine proposed by Mr. Ward Leonard. But to ask railway engineers to equip every electric locomotive with a large motor generator is asking too much, for its weight and cost would be considerable. Nor would the system be particularly efficient. A more recent suggestion is to change the alternating current into direct current with a mercury vapour rectifier, and experiments with this system are at present being carried out on the testing track of the New York, New Haven and Hartford Railway. With rectifiers, however, we are not at the moment concerned. A system that seems more promising is the split-phase system on which the American Westinghouse and American General Electric Company are now working.

A split-phase locomotive is equipped with polyphase driving motors, a phase converter, and controlling apparatus. Everyone knows, who knows anything about electrical matters at all, that a polyphase induction motor can be operated as a single-phase motor by connecting one phase to the line and giving the rotor a start. The machine will run at a speed somewhat less than its designed speed, but at no load very little indeed below that of the revolving field. From the three terminals of a three-phase motor—including the two into which single-phase current is fed—three-phase current may be taken. The output, however, is unbalanced, and the starting torque poor. Therefore a phase converter of this kind is unsuitable for single-phase locomotives, but the converter developed by the General Electric Company is almost as simple. It may, for the sake of convenience, be regarded as a two-phase induction motor, one of the stator windings of which is in series with one phase of the locomotive driving motor and transformer and the other phase in series with the remaining phase of the motor. By means of an auto-transformer, or extra turns on the secondary side of the main transformer, a part of the supply pressure is introduced into the last mentioned phase of the converter, and to secure a good power factor the rotor, which is fitted with an exciting winding in addition to its squirrel-cage winding, is fed with exciting current by an independent exciter. This description is not adequate, but it will no doubt convey to those familiar with alternating-current work some idea of the general principle of the split-phase system. It is claimed by Mr. Alexanderson, who is responsible for its development, that it is possible to produce with this cheap and light apparatus balanced polyphase currents and to work with polyphase motors trains that collect single-phase current from a single overhead wire.

The scheme is ingenious and interesting, and, as it is about to be adopted on an American railway, it is evidently well out of the experimental stage. But in view of what has been done and is being done in other countries, we are forced to ask whether the complications involved are really necessary. Thousands of single-phase commutator motors are now at work, and some have been working highly satisfactorily for several years. In France, Germany, Switzerland, and, in fact, all over the Continent, with the exception of Italy, where three-phase working is very popular, the ordinary single-phase system is gaining ground. Schemes for changing single-phase current into polyphase current and direct current have certainly been suggested and tried, but they seem now to have been wholly given up. There are, of course, several kinds of single-phase commutator motors, and different firms hold different views as to which is the best machine to employ. On the Brighton line use is made of the Winter-Eichberg compensated repulsion motors; on the Lötschberg line series compensated motors with commutating poles; on the Martigny Orsières Railway Déri motors; whilst on the Dessau-Bitterfeld line, in Germany, and the Midi Railway, in France, several kinds of motors have been tried. But in America the use of plain series compensated motors has been mainly adhered to, and it is possible, though we cannot say so definitely, that some of the continental machines give better results. Moreover, it must not be forgotten that on the Continent 15-cycle current is now usually employed, whereas in America most of the railways are worked with 25-cycle current. A polyphase induction motor—particularly a squirrel-cage motor—does undoubtedly offer certain advantages. It is simple, light, and efficient, and the most robust motor invented. But it is agreed pretty generally that its characteristics are not the best for traction service. A polyphase motor runs at constant speed at practically all loads, whereas the speed of a series motor varies constantly and automatically, and the machine adapts itself to the work it has to perform. The split-phase system may be good; it may not add appreciably to the cost of locomotives and motor coaches, it may not make a great difference to the weight; but all the same it introduces complications that the simple single-phase system does not. Of the merits and demerits of the system, however, it is not yet possible to speak. The fact that the two largest electrical firms in America are working upon it proves clearly and conclusively that the invention is something more than the invention of a crank. Very shortly the split-phase system will be put to the test of practical application, and the results will unquestionably be watched with very keen interest by railway engineers in all parts of the world.

### Glasgow Water.

FOR seven days a Select Committee of the House of Lords, composed of Lord Ribblesdale (chairman), the Earl of Onslow, and Lords Chelmsford, Gorell, and Rotherham, has been considering a Bill promoted by the Glasgow Corporation which, among other things, sought power to increase the water supply of the city by connecting Lochs Voil and Doine with Loch Katrine. In six years' time the supply available from the latter loch will, it is estimated, be overtaken. It was therefore proposed to dam up Lochs Voil and Doine and to turn part of the impounded water into Loch Katrine. The scheme would have involved the expenditure of about 1¼ millions, and would have taken about eight years to carry out, so that the Corporation was bestirring itself none too soon. After sitting for seven days, during which time the case for the Corporation was put forward in, to an outside observer, a most convincing way, the Committee intimated on Thursday of last week that the preamble to that part of the Bill relating to the new water scheme had not been proved. There was a large body of opposition to the scheme, but the Committee came to its decision immediately on the conclusion of the promoters' case and without hearing a single adverse witness. Following the usual practice of Select Committees, the chairman, when requested to do so, declined to give any reason for the decision, and as a result the surprise with which the intimation of the fate of the scheme has been received in Glasgow and elsewhere is mixed with great perplexity. The opposition to the scheme was largely either sentimental or hypothetical, or had been met and conquered fifty years ago, when Glasgow first came over the watershed to Loch Katrine for its supply. But as opposing witnesses were not heard, it can only be concluded that there was, in the opinion of the Select Committee, a *prima facie* defect in the case for the Corporation. This may have been the suggestion that Glasgow already uses too much water per head, and that by economy the need for increasing the available supply could be avoided; or it may have been the outcome of an impression that the head waters of the Clyde, Loch Lomond, or other source should be tapped in preference to Lochs Voil and Doine. However the matter is looked at, it seems as if the action of the Committee will be responsible in the near future for placing the Glasgow citizens on short commons in the matter of water for at least two or three years. The rejection

of the scheme will be noted with concern by other municipalities, and should attract considerable attention to the action of the Local Government Board, which, it is understood, is considering a Bill aiming at the scheduling and control of water catchment areas. It is proposed in this Bill, we understand, that a central body should be established to which all water schemes would be submitted in the first instance, and to which would fall the duty of advising Parliamentary Committees subsequently appointed to consider any given scheme.

## THE PREVENTION OF ACCIDENTS TO RAILWAY SERVANTS.

IT is announced that the President of the Board of Trade has appointed the following Committee to inquire into the working of the Railway Employment (Prevention of Accidents) Act, 1900, and to report what amendments, if any, are necessary:—Sir William Collins, K.C.V.O., M.D. (Chairman), Mr. G. N. Barnes, Mr. Oliver Bury, Sir Alfred Ewing, K.C.B., Mr. Walter Hudson, Mr. W. F. Marwood, C.B., and Sir Robert Turnbull. Mr. S. G. Spencer, of the Board of Trade, will act as secretary. Mr. Oliver Bury is a director and the late general manager of the Great Northern Railway. Sir Robert Turnbull is the general manager of the London and North-Western Railway, and was superintendent of the line from 1895 until Sir Frank Ree's death in February last. Sir Robert has had much to do with this Act, as he has been a member of the Railway Safety Appliances Committee appointed in April, 1906, by Mr. Lloyd George, when President of the Board of Trade. Mr. Hudson is a former servant of the North-Eastern Railway, and was a member of the 1899 Royal Commission that led to the passing of the Act; while Mr. Marwood is, of course, the Assistant Secretary of the Railway Department of the Board of Trade, and may be considered as the official member. The appointment of the Committee is the result of a debate on February 12th and 13th on an amendment to the reply to the King's Speech.

That much-discussed, but much-misunderstood, subject, automatic couplings, was really the origin of the Railway Employment (Prevention of Accidents) Act, 1900, into the working of which this inquiry is to be held. When Sir Michael Hicks-Beach, in 1889, brought in a Bill, as a sequel to the Armagh disaster of June of that year, to compel interlocking of points and signals on the 6·5 per cent. of English and Welsh, 18 per cent. of Scottish, and 41 per cent. of Irish railways not interlocked; to enforce the adoption of the block system on the 3 per cent. of the English and Welsh, 1 per cent. on the Scottish and 69 per cent. on the Irish railways not so protected; and to compel the fitting of continuous brakes to the 25 per cent. of the locomotives and 28 per cent. of the passenger stock in Great Britain and Ireland still unfitted at that time, he included a clause calling for wagons to be equipped with a system of automatic couplings such "as may for the time being be approved by the Board of Trade." Whilst there was practically no opposition to the remainder of the Bill, strong objection was taken to the automatic coupling clause, and in order to get the other and main portion through, Sir Michael Hicks-Beach dropped the opposed part.

In August, 1898, a parliamentary paper was published showing that during the ten years 1888–1897 there had been 180 men killed and 3344 injured in coupling and uncoupling wagons, and 1097 killed and 13,750 injured in other shunting accidents. Mr. (now Sir Francis) Hopwood, then Assistant Secretary for the Railway Department of the Board of Trade, went to Canada and the United States in the same autumn of 1898, and judging from the report he made on his return as to the benefits ensuing from the compulsory adoption of automatic couplings there, he evidently thought that they were not only desirable, but easy of adoption here. As a consequence his chief, Mr. Ritchie, introduced in 1899 a Bill to compel, *inter alia*, the adopting of automatic couplings.

The opposition of 1889 was tame compared with the objections raised against the proposals of 1899, and the feeling, especially of the owners of private wagons, was such that Mr. Ritchie had to withdraw the Bill and refer the whole subject of "the causes of accidents, fatal and non-fatal, to servants of railway companies and truck owners" to a Royal Commision over which Lord James of Hereford presided. The severest opponent of the companies could not say that the report of this Commission was adverse to their administration; in fact, the report almost opens with the remark that in 1872 there were three times as many fatal accidents as there had been in 1898. On the question of automatic couplings, it was stated that "Mr. Hopwood, the representative of the Board of Trade, who has devoted great attention to the subject, in giving evidence before us, stated that he was not prepared to recommend any automatic coupling for general use, and no witness who gave evidence before us was so prepared."

It was, however, shown that brake levers and labels were required on both sides of wagons, that propping and tow-roping were dangerous, power brakes were required on engines, together with the better lighting of goods yards, shunting sidings, and look-out men were desirable for the protection of platelayers. Recommendations as to these were made. As to automatic couplings, it was suggested that the companies, either voluntarily or by obligation placed upon them, should "make those practical experiments which we have pointed out ought necessarily to precede the general application of any system or automatic couplings."

No parliamentary action was taken as to automatic couplings. The Royal Commission suggested that a Departmental Committee should be appointed to watch the experiments just referred to, but nothing was done until Mr. Lloyd George went to the Board of Trade in December, 1905. Colonel (now Sir Arthur) Yorke was the chairman of the Committee then appointed, and Mr. (now Sir) Robert Turnbull, a member of the newly appointed Committee, was another. The Railway Safety Appliance Committee has done good work, but perhaps its most valuable achievement was to show the little necessity there was for automatic couplings here, and the engineering and financial difficulties in the way of their adoption.

The recommendations of the Royal Commission were duly embodied in a Bill, which became, without opposition, the Act of 1900, now under consideration. This gave the Board of Trade power to make and enforce rules for working, subject to an appeal from the companies to the Railway and Canal Commission, as to the reasonableness of a rule. The Board was also given powers to require the use of any plant or appliance which had been shown to the satisfaction of the Board of Trade to be calculated to reduce danger to persons employed on a railway or the disuse of any plant or appliance which had been similarly shown to involve such danger. Further, power was given "to inspect any railway for the purpose of ascertaining where there is any ground for proceeding under this Act or whether there has been any contravention of or default in compliance with any rule made under this Act."

The first set of rules came into force in August, 1902. There was some delay over them, as they included the provision of either-side brakes. The clause as to the latter was eliminated, and the others went forward, as just said. Either-side brakes provided work for the Board of Trade, Railway Commission, Safety Appliances Committee and the companies, but the last named won, and a rule, considerably modified from the original, came into force in November, 1911.

Coming now to the results of the Act, we consider that the first point to be noted is the number of men affected. The annual reports of the Board of Trade up to and including that for the year 1910, gave the "number of servants exposed to danger." This was taken from the triennial census sent to the Board of the number of men employed in various grades. In 1895 the number exposed to danger was 270,739, in 1898 it was 307,983, in 1901 the figure was 325,671, which rose slightly—to 325,868—in 1904. In 1907 the maximum of 342,094 was reached, and this fell to 331,296 in 1910. The reports for 1911 and 1912 did not give these particulars, only the total number employed, but the result is not affected, as the last census taken was in 1910.

In order to test the matter properly, we will go back to 1896—that is, five years before the Act came into force. We will also separate shunting accidents from other accidents. The result is as follows:—

| Year. | In shunting accidents. | | In other than shunting accidents. | |
|---|---|---|---|---|
| | Killed. | Injured. | Killed. | Injured. |
| 1896 | 136 | 2548 | 308 | 1285 |
| 1897 | 97 | 2400 | 404 | 1589 |
| 1898 | 129 | 2164 | 359 | 1875 |
| 1899 | 116 | 2357 | 396 | 2080 |
| 1900 | 136 | 2616 | 423 | 1789 |
| 1901 | 88 | 2309 | 415 | 1778 |
| 1902 | 92 | 2013 | 351 | 1700 |
| 1903 | 97 | 2046 | 349 | 1613 |
| 1904 | 74 | 2131 | 335 | 1676 |
| 1905 | 76 | 2066 | 317 | 2622 |
| 1906 | 81 | 2270 | 344 | 1955 |
| 1907 | 79 | 3150 | 362 | 2427 |
| 1908 | 97 | 2795 | 279 | 2181 |
| 1909 | 65 | 2577 | 253 | 2022 |
| 1910 | 77 | 2679 | 297 | 1926 |
| 1911 | 81 | 2888 | 304 | 2308 |
| 1912 | 60 | 3070 | 277 | 2338 |

It will, from the above figures, be seen that the number of fatal accidents in shunting for the five years 1896–1900 inclusive was 614, whilst during a similar period, ten years later, although the number of men exposed to danger had increased many per cent., the number was only 399, a decrease of 215, or 35 per cent. If other accidents are compared for the same two periods, it will be found that there is a drop from a total of 1890 to a total of 1535, a decrease of 355, or 18·8 per cent. Or, if the averages per annum for the five years 1896–1900 be taken and compared with the average per annum for 1906–1910, it will be seen that the average number of fatal shunting accidents fell from 123 to 80, a decrease of 35 per cent, while if the seven-year period 1906–1912 be taken, the decrease is 37·4 per cent. The average number of fatal accidents in other than shunting accidents for 1896–1900 was 378 per annum. This figure was reduced to an average for 1906–1910 of 307 per annum, a fall of 18·8 per cent., while if the seven-year period 1906–1912 be taken, the average is 302, a reduction of 20·1 per cent.

That there has been an increase in the number of non-fatal cases is admitted. But this is due to two factors. First, there was a change made at the end of the year 1906 in the method of reporting non-fatal accidents. This led to an increase of returns, as will be seen from the rapid jump in 1907 in the table just given. Secondly, the companies, due probably to pressure from the Board of Trade have been reporting non-fatal accidents, particularly those in goods stations, engine sheds, &c., more carefully. The number of non-fatal casualties in shunting increased 11·4 per cent. when the five years 1906–1910 are compared with 1896–1900, and those in other than shunting accidents increased 21·9 per cent. in the same periods. It must be remembered that, in addition to the two factors just named, there has been an increase of 11·8 per cent. in the number of men exposed to danger.

There is yet another test by which the improved conditions of the men may be ascertained. There are two assistant inspecting officers and three sub-inspectors, whose duty it is to inquire into those accidents to railway servants which suggest that there has been some want of discipline, defective appliances or improper methods of working. In the report for each year a table is given where every accident is classified under one of six headings, three of which may be regarded as covering preventable causes, *i.e.*, defective apparatus, neglect of rules, want of rules or system, &c. From these annual returns we gather the following suggestive figures:—

| Year. | No. of casualties. | Number and proportion of all accidents inquired into. | | Number and proportion of all accidents reported as preventable. | | Number and proportion of accidents inquired into which were reported as preventable. | |
|---|---|---|---|---|---|---|---|
| 1905 | 4081 | 717 | 17.5 | 239 | 5.8 | 145 | 20.22 |
| 1906 | 4650 | 753 | 16.2 | 245 | 5.25 | 130 | 17.27 |
| 1907 | 6018 | 841 | 13.9 | 240 | 4.0 | 132 | 15.22 |
| 1908 | 5352 | 827 | 15.4 | 247 | 4.6 | 136 | 16.4 |
| 1909 | 4884 | 777 | 15.9 | 247 | 5.05 | 134 | 17.25 |
| 1910 | 4955 | 819 | 16.5 | 232 | 4.7 | 131 | 16.0 |
| 1911 | 5539 | 869 | 15.7 | 237 | 4.3 | 146 | 17.0 |
| 1912 | 5709 | 736 | 12.8 | 232 | 4.06 | 119 | 16.17 |

In view, then, of these facts, it really seems that there are no good grounds for the inquiry now ordered, and it looks as though the companies and the country are being put to an unnecessary expense.

## BOOKS RECEIVED.

*Les Machines à Vapeur.* By F. Cardier. Paris: O. Doin et Fils. Editeurs, 8, Place de l'Odeon. Price 5f.

*Invest in the Tropics.* London: The Tropical Agriculture Development Agency, Limited, 17, Waterloo-place, London, S.W.

*Text-book on Railroad Surveying.* By G. W. Pickels and C. C. Wiley. London: Chapman and Hall, Limited. Price 10s. 6d. net.

*Some Fundamental Problems in Chemistry, Old and New.* By E. A. Letts. London: Constable and Co., Limited. Price 7s. 6d. net.

*The Importer's Sterling Advance Tables.* By T. R. Lanskail. London: Sells, Limited, 168–167, Fleet-street, E.C. Price 8s.

*Steam Turbines.* By James Ambrose Moyer. Second edition. London: Chapman and Hall, Henrietta-street, W.C. Price 15s. net.

*The Gas Turbine.* By Norman Davey. London: Constable and Co., Limited, 10, Orange-street, Leicester-square. Price 15s. net.

*How to Understand Aeroplanes.* By S. L. Walkden. London: Percival Marshall and Co., 66, Farringdon-street, E.C. Price 1s. net.

*Practical Ironfounding.* By Joseph G. Horner. Fourth edition. London: Whittaker and Co., 2, White Hart-street, E.C. Price 5s. net.

*Constructions Navales, Accessoires de Coque.* By M. Edmond. Paris: O. Doin et Fils. Editeurs, 8, Place de l'Odeon. Price 5f.

*Mechanics and Heat.* By W. B. Anderson. London: The Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 8s. 4d. net.

*Marine Engineering.* By A. E. Tompkins. Fourth edition. London: Macmillan and Co., Limited, St. Martin's-street. Price 15s. net.

*Ornamental Lathework for Amateurs.* By C. N. C. London: Percival Marshall and Co., 66, Farringdon-street, E.C. Price 3s. 6d. net.

*Industrial Co-Partnership.* By Charles Carpenter. London: Co-Partnership Publishers, Limited, 6, Bloomsbury-square, W.C. Price 1s. net.

*Some Famous Buildings and their Story.* By A. W. Clapham and W. H. Godfrey. London: Technical Journals, Limited, Caxton House, S.W. Price 5s. net.

*Advertising and Progress.* A Defence by E. S. Hole and a Challenge by John Hart. London: *Review of Reviews*, Bank-buildings, Kingsway, W.C. Price 5s. net.

*A Text-book on Physics (Electricity and Magnetism).* By J. H. Poynting, F.R.S., and Sir J. J. Thomson, O.M., F.R.S. London: C. Griffin and Co., Limited. Price 10s. 6d.

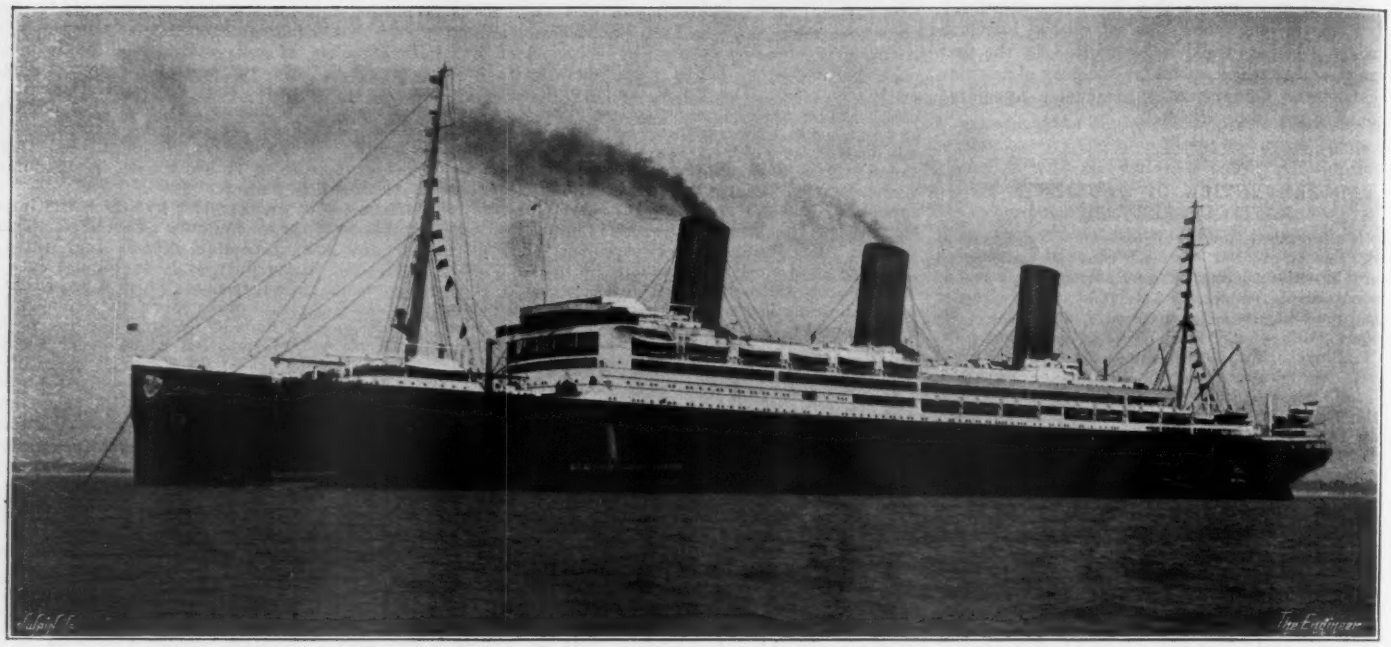
*A Handbook on the Steam Engine.* By Herman Haeder. Translated by H. H. P. Powles. Fourth edition. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. Price 7s. 6d. net.

*Practical Instructions in the Search for and the Determination of the Useful Minerals, including the Rare Ores.* By A. McLeod. London: Chapman and Hall, Limited. Price 5s. 6d. net.

*Old English Pattern Books of the Metal Trades: A Descriptive Catalogue of the Collection in the Victoria and Albert Museum, South Kensington.* London: His Majesty's Stationery-office. Price 6d.

# THE HAMBURG-AMERICA LINER VATERLAND

MESSRS. BLOHM AND VOSS, HAMBURG. BUILDERS



## THE HAMBURG-AMERICA LINER VATERLAND.

LESS than a year ago, by the kind invitation of the directors of the Hamburg-America Line, we had the opportunity of seeing for ourselves their latest liner, the Imperator—53,000 tons—at that time the largest vessel afloat, which left Cuxhaven on her maiden voyage to New York on June 9th, 1913. This year we have again been privileged to enjoy the company's hospitality, the occasion being the maiden voyage of the Vaterland, which is larger than her elder sister by about 5000 tons. It is impossible in attempting a short description of the main features of this ship to avoid comparisons between her and the Imperator. We are assured by her designer that whatever improvements may have been introduced with regard to her public rooms and accommodation generally, any changes in the construction of her hull have been brought about by a careful study of the improvements in the design of the latest German cruisers, and not on account of lessons learned from experience with the Imperator.

Much has been said and written with regard to the wisdom of building these vast ships and to their safety when built. We do not propose to enter into these arguments beyond saying that in the case of the Vaterland every possible precaution against mishap that money can buy and that human ingenuity has devised has been adopted. Her double bottom extending under the whole ship 6ft. above the bottom plating and her double skin built right round the ship and reaching far above the water line, are features to be found in the Imperator—and, we may add, in the Britannic and Aquitania—which vessel she also resembles in the number and strength of her watertight compartments. Transverse and longitudinal, they extend upwards 50ft. from the double bottom. The doors which connect them for the passage of firemen and others who have to pass from one compartment to another are operated by the Stone-Lloyd hydraulic system. The pressure passes and returns through a central controlling valve operated from the bridge. When the lever on the bridge pedestal connected with this valve is up all doors are open. Mechanical gongs give notice that the doors are about to close, and on the lever being pressed down, in twenty seconds all are shut fast. The pressure exerted is strong enough to enable them to crush through coal, an important fact where the bunkers are involved. Each door, however, can be operated by a local control valve. Thus when the "opening" pressure is on from the bridge any door may be closed by moving the lever connected with the valve of the particular door. The door, however, will remain closed until the lever is reversed. Similarly, if the "closing" pressure is on from the bridge any door may be opened, but in this case directly the hand pressure on the local lever is removed the door passes under the control of the central lever on the bridge and is automatically closed.

The Vaterland is equipped with eighty-three boats, two of which are driven by motors. This boat installation has accommodation for 5600, the full complement of passengers and crew being 5350. The Welin system of launching is in use, as in the Imperator, whereby each boat is controlled by one man. A large number of boats has been placed on the lower promenade deck, 20ft. lower than the boat deck. But, nevertheless, in a rough sea their launching must always be attended with considerable risk.

The engines are similar to those installed in the Imperator, but we may briefly state their general arrangement. The ship is driven by four four-bladed propellers, making normally 185 revolutions, as compared with 175 in the earlier ship. The propelling machinery, consisting of quadruple turbines of combined impulse and Parsons type, is accommodated in three engine-rooms, the foremost of which is 69ft. long and the two others 95ft. long. There is a passenger lift in each engine-room. The total ahead horse-power is about 72,000, giving an average speed of about 23½ knots. In the Imperator an average of 22¼ knots is produced, the ahead horse-power being 62,000. Dr. Foerster, who designed the Vaterland, informed us that this increased speed is due to the improvement in the construction of her stern, which below water is shaped like that of a cruiser, whereas above water it is similar to what we are accustomed to see in ships of the merchant service. He told us that he met with considerable difficulty in combining the two, and success was not finally reached until much time had been spent at the experimental tank at Bremerhaven.

The steam when "going ahead" passes first to a high-pressure turbine on one of the inner shafts, then to an intermediate-pressure turbine on the other inner shaft, and then is equally divided in two low-pressure turbines on the outer shafts. Each separate shaft is available, however, by itself for running or manœuvring. The astern turbines are sub-divided into two equal high-pressure and low-pressure turbines, the low-pressure being again arranged on the outer shafts. The combined astern horse-power amounts to 35,000, as in the Imperator. The total turbine installation has 760,000 bronze blades. The thrust bearings have a surface of about 75 square feet altogether. The exhaust steam is condensed in four condensers of pear-shaped section, each having a cooling surface of 16,150 square feet. Four centrifugal pumps of 4ft. 3in. diameter, driven by two engines, supply the cooling water for the condensers. Four double-feed pumps draw the feed water from the tanks in the double bottom, and, in conjunction with four main feed pumps, deliver it into the boilers.

There are forty-six single water-tube boilers of Yarrow type arranged in four rooms, each 75ft. long and extending with their bunkers over the whole width of the ship. The necessary steam is generated at a pressure of 235 lb. on the inch. The total heating surface is 203,000 square feet, and the total grate area 3760 square feet. These figures are exactly the same as those given for the Imperator, and it is remarkable that the later ship should be able to develop normally over 16 per cent. more power—72,000 to 62,000. The air required for the forced draught is drawn by four fan blowers. Each of these blowers has a fan of 13ft. 9½in. diameter, and forces the air through channels of 45 square feet cross section into the space under the grating of the furnaces. Four ash ejector pumps with 6356 cubic feet capacity per hour, sixteen ash ejectors, six ash hoists and three ash cooling valves are provided for dealing with the ashes and sending them overboard. Four steam bilge pumps, each of 4944 cubic feet capacity per hour, continuously empty the bilges of the engine and boiler-rooms. Four feed-water purifiers, two oil separators, as well as two mixing feed-water heaters and two economisers for heating the feed water, are provided.

An efficient electric lighting system contributes to comfort and safety. Current is generated by five turbo-generators of 2000 ampères capacity at 110 volts, which serve 10,000 electric lamps in the ship. A sixth dynamo of 100 ampères is placed far above the water line, ensuring partial light even if the machines in the lower engine-room are disabled. A completely fitted machine shop is situated in the forward engine-room, containing lathes, drills, planers, &c. The ship is fitted with Frahm anti-rolling tanks.

An important feature of this vessel is that the uptakes from the boiler-rooms do not pass directly through the centre of the ship, but divide at a point beneath the lowest passenger deck, pass up the sides and join again in a single tube above the boat deck. The most valuaole effect of this arrangement is that the ventilation of the boiler-rooms is enormously improved. In addition to this, it has become possible to have three alleyways running fore and aft without interruption in the passengers' quarters, which add greatly to their convenience and give an effect of great space.

The Hamburg-America Line aims at making its passengers feel more as if they were staying in some large and luxurious hotel in London or New York than travelling across the Atlantic. The main public rooms, with the exception of the first-class dining-room, are on the promenade deck and their decoration is overpowering in its gorgeousness. For ourselves, we must confess to a love of greater simplicity. Special mention must be made of the ball-room on account of its large dimensions. Its length is 80ft., its width 58ft., and its height 21½ft. The roof is suspended from lattice girders. The first-class dining-room has accommodation for 800 passengers and can thus seat all the first-class passengers at once. The gallery which surrounds this room in the Imperator has been dispensed with in the Vaterland and the room has been enlarged. Its dimensions are 135ft. long, 30ft. high, and it extends in width right across the ship. Its beauty is impaired by the decoration of the dome, which is painted in most vivid colours and the effect is not harmonious. Space will not allow us to describe the restaurant, palm court, smoking-room, drawing-room, and the many other rooms set apart for reading and writing. It is enough to say that no expense has been spared in studying the comfort of the passengers.

Numerous facilities for amusement have been provided. If you care to walk four and three-quarter times round the main promenade deck you may be content in that you have completed a mile. The swimming bath, 65ft. long and 41ft. wide, has a maximum depth of 9ft. In addition, there are electric and steam baths and gymnasia, &c., the first and second-class passengers' containing everything that the most exacting can require.

It may be of interest to give some dimensions and statistics of the Vaterland as compared with those of the Imperator.

| | Imperator. | Vaterland. |
|---|---|---|
| Length | 920ft. 6in. | 950ft. |
| Beam | 98ft. | 100ft. |
| Tonnage | 52,100 | 58,000 |
| Passengers | 4,020 | 4,100 |
| Crew | 1,180 | 1,250 |

The Vaterland was built by Blohm and Voss, of Hamburg, to the designs of Dr. Foerster, naval architect to the Hamburg-America Line. Her keel was laid in September, 1911, and she was launched

on April 3rd, 1913. On her trials against a gale blowing 60 miles an hour she averaged 25.4 knots; with the wind behind she increased her speed to 26.3 knots. At one period her engines developed 90,000 horse-power. There is, however, no intention on the part of her owners of competing with the Mauretania and Lusitania in point of speed. The average speed of the Vaterland will probably be about 23½ knots, the horse-power produced being about 73,000.

We publish a photograph of the ship, taken by Becken and Son, of Cowes, when she was at anchor in the Solent before proceeding to Cherbourg last Friday morning.

In conclusion, we desire to express our thanks to the Hamburg-America Line for its hospitality and for allowing us to see for ourselves the latest and largest product of German shipbuilding.

## SHOOTING IN THE NAVY.

THE Blue-books dealing with the shooting in the Navy during the year 1913, which have recently been issued, are even more puzzling than usual, and it is harder than ever to deduce from them any useful comparison between the practice during the year 1913 and that of previous years. We shall not, therefore, attempt to make any general comparison as we have done on former occasions, and shall content ourselves by giving an abstract of the present reports, which are entitled "Result of Battle Practice in His Majesty's Fleet in 1913," and "Result of Test of Gunlayers with Heavy Guns and Light Quick-firing Guns in His Majesty's Fleet, 1913."

Taking the first mentioned, we find at the outset that there has been a rearrangement in the returns. The corresponding Blue-book of 1912 lumped battleships and battle-cruisers together. The present report divides them up into Class I., "Battleships of 'Dreadnought' and later Classes and Battle-cruisers;" Class II., "Battleships prior to 'Dreadnought' class" During 1913 fifteen battleships of the "Dreadnought" and later classes and battle-cruisers took part in the battle practice. Seven of these vessels were armed with 13.5in. guns and eight with 12in. guns. The results they achieved were exceedingly divergent. We may say that the general conditions under which firing took place are given as being "good," "very good," and "excellent," so that it may be taken that there was not any very great difference in the weather or in other atmospheric factors which go to influence the shooting. The variation in the results is therefore all the more noteworthy. These results—separating the 13.5in. gun ships from the 12in. gun ships—are as follows :—

| Order of merit. | 13.5in. Guns. | Points. | Order of merit. | 12in. Guns. | Points. |
|---|---|---|---|---|---|
| 1 | King George V. | 974 | 4 | Dreadnought | 651 |
| 2 | Princess Royal | 786 | 6 | Neptune | 590 |
| 3 | Monarch | 766 | 7 | Bellerophon | 550 |
| 5 | Orion | 635 | 8 | Inflexible | 512 |
| 9 | Thunderer | 506 | 10 | Indomitable | 481 |
| 12 | Centurion | 457 | 11 | St. Vincent | 464 |
| 14 | Lion | 334 | 13 | Collingwood | 397 |
| | | | 15 | Vanguard | 302 |

It will be observed that the King George V.'s score is nearly three times that of the Lion, while the Dreadnought's score is more than twice that of the Vanguard. Moreover, the 12in. gun Dreadnought comes fourth in the entire list, while the 13.5in. gun Lion is fourteenth.

In Class II.—"Battleships Prior to 'Dreadnought' Class"—nineteen ships took part. All these ships had a primary armament of 12in. guns, the majority having a secondary armament of 6in. guns, though in some cases there were 9.2in., and in a few a combination of 9.2in. and 6in. guns. The weather conditions were very varying. They are given as being "excellent, "very good," "good," "unfavourable," "difficult," and "very difficult." It is impossible, therefore, to form a correct estimate of the relative shooting efficiency of the various competing units. We may say, however, that the points scored by the first four vessels were :—

| Ship. | Score. | Conditions. |
|---|---|---|
| King Edward VII. | 515 | Very good |
| Dominion | 477 | Good |
| Commonwealth | 430 | Very good |
| Venerable | 334 | Very good |

At the other end of the list come the four vessels given in the following table :—

| Ship. | Points. | Conditions. |
|---|---|---|
| Zealandia | 156 | Very good |
| Britannia | 142 | Good |
| Hibernia | 117 | Good |
| Cornwallis | 115 | Very difficult |

No doubt there may be numerous factors, in addition to the weather, &c., which enter into the matter and which are not disclosed; but it is hard for those without internal information to understand why, for instance, under practically similar conditions, both being classed as "very good," the King Edward VII. should, on the one hand, return a score of 515 points, while the Zealandia, with an exactly similar armament, could only obtain 156 points.

In Class III.—"Cruisers"—thirteen ships are mentioned. In this case, though the conditions are all reported as being more or less favourable, comparison is again difficult because of the variation in armament, some of the vessels having 9.2in. guns, some 7.5in., and some 6in. We, however, give the first four and the last four units in the accompanying table :—

| Order of merit. | Ship. | Armament. | Score. | Conditions |
|---|---|---|---|---|
| 1. | Roxburgh | 4–7.5in. I.; 6-6in. VII... | 550 | Excellent |
| 2. | Achilles .. | 6–9.2in. X.; 4-7.5in. II. | 446 | Good |
| 3. | Monmouth | 14–6in. VII. and VIII. .. | 443 | Good, strong glare |
| 4. | Hampshire | 4–7.5in. I.; 6-6in. VII... | 431 | Good |
| 10. | Natal .. | 6–9.2in. X.; 4-7.5in. II. | 245 | Very good |
| 11. | Shannon | 4–9.2in. XI.; 10-7.5in. II. | 179 | Very good |
| 12. | Donegal | 14–6in. VII. and VIII. .. | 107 | Excellent |
| 13. | Argyll | 4–7.5in. I. and 6in. VII. | 102 | Excellent |

Here, again, some curious divergencies will be noticed. The Achilles and the Natal, with identical armament and with "excellent" and "very good" conditions, scored 446 and 245 respectively. The Monmouth and Donegal, with similar guns, scored 443 and 107 respectively, notwithstanding that the Donegal's conditions were "excellent" and the Monmouth's "good," but with a "strong glare." Still more noteworthy is the difference between the shooting of the Roxburgh, which heads the list, and the Argyll, which ends it. Both vessels are armed in a similar manner and both were operating under "excellent" conditions, yet the score of the Roxburgh was nearly five and a half times as big as that of the Argyll.

In Class IV.—"Light Cruisers"—returns are given from ten vessels. The majority of these are armed either with 4in. VII. or 6in. XI. guns alone, though the Liverpool and the Newcastle have both types of guns. The scores of the first three and last three vessels are as follows :—

| Order of merit. | Ship. | Armament. | Score. | Conditions. |
|---|---|---|---|---|
| 1. | Amphion | 10–4in. VII. | 817 | Excellent |
| 2. | Chatham | 8–6in. XI. | 597 | Excellent |
| 3. | Liverpool | 2–6in. XI.; 10-4in. VII. | 569 | Excellent |
| 8. | Active | 10–4in. VII. | 374 | Excellent |
| 9. | Weymouth | 8–6in. XI. | 363 | Excellent |
| 10. | Southampton | 8–6in. XI. | 280 | Very good |

It will be seen that the Amphion scored more than twice as much as the Active, though both fired under "excellent" conditions and both had the same guns. Similarly, the Chatham obtained more than twice as many points as the Southampton, though the armament was the same in both vessels, and the only difference was that whereas the conditions were "excellent" in one case, they were "very good" in the other.

A noticeable fact is that the score of the vessel heading the list in each class was considerably in excess of that of the vessel coming next in order of merit. Thus, in Class I. the difference was 188 points; in Class II., 38 points; in Class III., 104 points; and in Class IV., 220 points.

The remainder of this Blue-book relates chiefly to the firing of the destroyers. We learn that out of nine boats of the "K" class, the Spitfire led with 153 points and the Achates was last with 66 points. In both cases the conditions were "excellent." Of thirty-nine boats of the "H" and "I" classes, the Larne led with 162 points and the Beaver was last with 61 points; but whereas the Larne had "good" conditions, those of the Beaver were "unfavourable." The Sandfly, however, which also had "good" conditions, only managed to make one point more than the Beaver. Sixteen vessels of the "G" class fired. The Wolverine was first with 210 points gained under "excellent" conditions, and the Renard second with 144 points—a difference of 66—obtained under "good" conditions. At the other end of the list were the Scourge with 76 points and the Scorpion with 68 points, the conditions being "excellent" and "good" respectively.

Of the vessels of the "F" class armed with 4in. guns, the Nubian, with 160 points, was first and the Maori fifth and last, with 82 points, the conditions in both cases being "excellent." Of the "F" class armed with 12-pounder guns, the Mohawk led with 206—conditions "good"—and the Tartar, with a score of 95, was fifth and last with "excellent" conditions.

Returns are given from twenty-three boats of the "E" class. The first and second were the Stour, with 215, and the Cherwell, with 185, and the two last, the Swale, with 76, and the Dee, with 75, the conditions in all cases being "good." In classes "A," "B," "C," and "D," which are lumped together, there were forty-nine boats. The scores of the first three and last three were as follows :—

| Order of merit. | Boat. | Score. | Conditions. |
|---|---|---|---|
| 1 | Mermaid | 166 | Good |
| 2 | Osprey | 148 | Good |
| 3 | Flirt | 145 | Good |
| 47 | Kestrel | 73 | Good |
| 48 | Success | 67 | Unfavourable |
| 49 | Peterel | 65 | Good |

In the Blue-book giving the results of tests of gunlayers in 1913, we notice, first of all, that whereas in past years there were two Blue-books devoted to this purpose, one of these being for heavy guns and the other for light quick-firing guns, this year these two sets of returns have been combined in one book. One of the chief points of interest contained in it is the following table, which compares the years 1910, 1911, 1912, and 1913 :—

| Nature of gun. | In scoring time. Rounds fired. 1910. | 1911. | 1912. | 1913. | Percentage of hits to rounds fired. 1910. | 1911. | 1912. | 1913. |
|---|---|---|---|---|---|---|---|---|
| 13.5in. B.L. Mark V. | — | — | 126 | 171 | — | — | 58.00 | 66.66 |
| 12in. B.L. K.E. VII and later | 525 | 560 | 623 | 214 | 48.90 | 37.30 | 54.74 | 51.40 |
| 12in. B.L. before K.E. VII. | 260 | 287 | 141 | 13 | 32.30 | 35.20 | 35.46 | 38.46 |
| 10in. B.L. Marks VI. and VII. | 26 | 30 | — | 10 | 23.07 | 33.33 | — | 40.00 |
| 9.2in. two gun turrets | 106 | 66 | 104 | 55 | 50.90 | 53.03 | 45.20 | 41.81 |
| 9.2in. single gun turrets | 444 | 461 | 427 | 102 | 55.60 | 55.30 | 55.74 | 58.82 |
| 7.5in. B.L. Mark II. | 250 | 256 | 251 | 38 | 52.00 | 58.20 | 52.20 | 68.42 |
| 7.5in. B.L. Mark I. | 123 | 108 | 116 | 19 | 39.80 | 39.08 | 33.20 | 21.05 |
| 7.5in. B.L. Marks III. and IV. | 144 | 143 | — | 48 | 45.10 | 48.30 | — | 54.16 |
| 6in. B.L. Marks XI. and XII. | 250 | 323 | 436 | 225 | 53.60 | 49.50 | 49.77 | 53.33 |
| 6in. B.L. Marks VII. and VIII. | 2266 | 3024 | 2104 | 604 | 46.20 | 49.90 | 49.65 | 42.54 |
| 4in. B.L. | 681 | 1153 | 1412 | 1863 | 44.10 | 42.00 | 38.50 | 55.34 |
| 6in. Q.F. | 1002 | 934 | 231 | 119 | 63.30 | 58.60 | 63.60 | 51.26 |
| 4.7in. Q.F. | 579 | 497 | 396 | 328 | 42.70 | 40.60 | 38.60 | 28.65 |
| 4in. Q.F. | 896 | 937 | 678 | 285 | 48.50 | 47.00 | 42.04 | 48.07 |

It will be observed that in the large majority of cases fewer rounds were fired in 1913 than in either of the three preceding years. The most noteworthy exceptions are the 13.5in. and the 4in. breech-loading guns. In both cases there is also an increased percentage of hits to rounds fired over all of the other three years recorded. The percentage of hits to rounds fired was, on the whole, greater than the average. The principal exceptions were the following :—

| Gun. | Percentage of hits to rounds fired. 1913. | Average of 1910, 1911, and 1912. | Points below three-year average. |
|---|---|---|---|
| 9.2in. two gun turrets | 41.81 | 49.71 | 7.90 |
| 7.5in. B.L. Mark I. | 21.05 | 38.36 | 17.31 |
| 6in. B.L. Marks VII. and VIII. | 42.54 | 48.58 | 6.04 |
| 6in. Q.F. | 51.26 | 61.83 | 10.57 |
| 4.7in. Q.F. | 28.65 | 40.63 | 11.98 |

A fewer number of ships took part in the tests than had been the case in the preceding years, the numbers being :—1910, 127; 1911, 134; 1912, 116; and 1913, 67; while only one-third the number of men fired, the numbers being 1522, 1671, 1528, and 528 for the four years respectively. No explanation is given of this.

From the figures given regarding guns smaller than 4in. quick-firing, we have compiled the following table :—

| Gun. | Percentage of hits to rounds fired. Average of years 1910, 1911 and 1912. | Figures for 1912. | Figures for 1913. |
|---|---|---|---|
| 12-pdr., 18 cwt., and 14-pdr. Q.F. | 58.66 | 60.17 | 54.09 |
| 12-pdr., 12 cwt. Q.F., and 8 cwt. | 50.68 | 68.78 | 60.03 |
| 6-pdr. and 3-pdr. Q.F. | 40.94 | 63.56 | 39.33 |
| 3-pdr. Vickers | 54.04 | 77.82 | 52.00 |

It will be seen that though the figure for 12-pounder, 12 cwt. quick-firing, and 8 cwt. guns—60.03—was considerably greater than the average of the figures for 1910, 1911, and 1912, yet with the other guns the 1913 figures were all below the averages of these three years. In no case did the 1913 figures equal those of 1912; but probably the latter may be regarded as phenomenal. They were certainly exceedingly good.

## THE CONTROL OF MARINE TURBINES FROM THE NAVIGATING BRIDGE.

IN our issue of May 10th, 1912, we published a description of the United States naval collier Neptune, a vessel fitted with Westinghouse turbines and speed reduction gearing. In that article it was briefly mentioned that the propelling machinery was not only under the direct control of the engine-room, but was also adapted to be controlled separately from the navigating bridge. Since this bridge-control system was first fitted to the Neptune its details have been more or less modified, and in this article we propose describing the features of the mechanism as it is now constructed.

The broad principle of the system is the use of compressed air to transmit the movements of the bridge-control handle to the engine-room and the use of oil under pressure to operate the relays actuating the steam inlet nozzle valves.

A little reflection on this general statement shows us that the problem involved in the design of this method of control is similar to that encountered in the design of steam steering gear. In both cases fluid pressure is employed to effect the movement of certain parts, and when these parts have been moved into the desired position the fluid pressure is relied upon to hold them stationary in that position against the action of certain restoring forces. If the fluid pressure diminishes, whether by leakage or condensation, the restoring forces will master the control. If it increases unintentionally the movement of the parts will exceed that set by the control.

The problem of controlling marine turbines from the navigating bridge by means of a fluid pressure transmission system is thus more complex than it appears at first sight. Were it merely a matter of controlling the starting and stopping of the turbines, the system could be arranged quite simply by means of an air or oil cylinder in the engine-room. When the piston of this cylinder was at one end of its stroke the turbine nozzle valves could be full open, and when at the other end they could be completely closed. The exact magnitude of the fluid pressure required to operate this piston would be immaterial. Nor would it matter whether the pressure leaked away after the movement of the nozzle valve control ring had been effected, for when the valves were once fully open or fully closed there would be no necessity for applying a force to hold them fully open or fully closed. In the limiting positions of the nozzle valve ring no restoring or opening force would—or rather, need—act on it.

Actually, however, it is required to maintain the nozzle valve ring in positions intermediate between the fully open and fully closed, for the bridge control has to regulate the speed as well as the starting and stopping of the machinery. It has, in fact, to do all that the ordinary ship's telegraph will do, but without the intervention of the man in the engine-room. Put simply, it has to be arranged that the air or oil cylinder, already referred to, has to operate in the following manner :—When it is deprived of fluid pressure it has to bring about the complete closure of the nozzles; when the full fluid pressure is admitted to the cylinder the nozzles have to be thrown fully open; when any intermediate pressure is in existence the nozzles have to be open to a proportionate extent. A definite position of the nozzle valve ring thus corresponds with a definite position of the piston in the operating cylinder, and this definite position of the piston corresponds in turn with the maintenance of a definite pressure in the cylinder. Obviously, if this pressure falls away by leakage the nozzles will tend to close, while if it should rise accidentally the nozzles will open farther. In both events the speed of the turbines will not be that arranged for from the bridge. As pipes and connections which do not leak are unknown, and as it is scarcely possible to guarantee that the supply of fluid will remain absolutely constant in pressure, it is necessary to provide means whereby leakage of pressure will be made up and a rise of pressure reduced before the loss or increase can produce any material alteration in the setting of the nozzle valve ring.

In the Westinghouse bridge-control system the operating fluid between the bridge and the engine-room is compressed air. This is supplied by a standard Westinghouse air brake compressor. This constant pressure supply is taken to the bridge-control valve and is there stopped completely, reduced in pressure, or sent through to the engine-room at full pressure according to the position of the control handle in its quadrant. The exact pressure transmitted to the engine-room is, in fact, proportional to the arc through which the control handle is swung.

The construction of the mechanism involved in this part of the system is shown in diagram in Fig. 1. The bridge-control handle A is mounted on a shaft which

carries a double cam B. Against this cam the nose of a plunger C is pressed. This plunger is hollow, has both ends closed, and is provided with ports at D and E. It works inside a piston F provided with a projecting sleeve G. In this sleeve are formed ports H. The piston and plunger are enclosed in a cylinder, and each is acted upon by a spring. It will be noticed that a port is formed in the piston at J and another in the cylinder wall at K. It will be noticed, too, that, as represented in Fig. 1, the

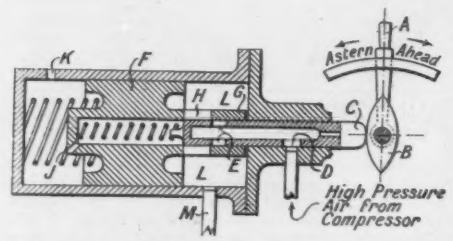



Fig. 1—DIAGRAM OF CONTROL VALVE

control handle A is in the mid or "stop" position, and that when this is so the right-hand edge of the ports H is just in line with the left-hand edge of the ports E, while the left-hand edge of the ports H is just in line with the left-hand end of the plunger C.

In all positions of the mechanism the port D in the plunger is always in communication with the high-pressure air supply. This supply is of a sensibly constant pressure. The function of the valve we have just described is to change this high pressure into a pressure proportional to

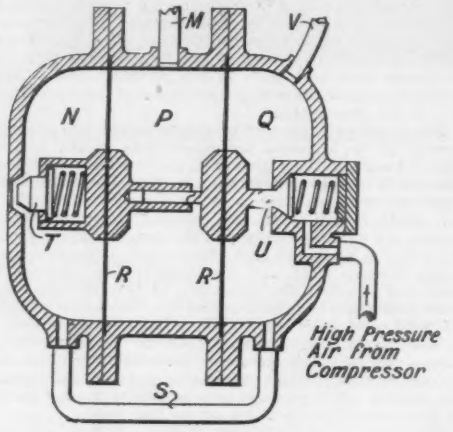



Fig. 2—RELAY

the arc through which the handle A is swung. Let this handle be swung ahead through an angle $a$. The cam B will then push the plunger C inwards through a proportional amount—say, through a distance $d$—and as a result the ports E will open the ports H by a like amount. High-pressure air is now free to flow from the compressor through the ports D E H into the space L. This air acts on the piston F and pushes it over to the left against the action of its spring. This movement ceases when the piston has been pushed through the distance $d$, for at this point the ports H close the ports E and the communication with the compressor is cut off. Air under pressure is thus trapped in the space L; but what is the pressure of this air? At first sight it looks as if it must be the constant pressure created by the compressor. But this is not so. The pressure is proportional to the distance $d$ through which the piston and plunger have moved. That it must be so is made evident by considering the equilibrium of the piston F. Neglecting friction, the air pressure on its right-hand face is balanced by the push of the spring on the left-hand face. This spring has been compressed through a distance $d$ and is therefore exerting a push proportional to this compression. The pressure in the space L must therefore also be proportional to the compression $d$, or, in other words, to the angle $a$, through which the control handle A has been swung. The explanation of why it should be so is obviously to be found in the fact that the full pressure delivered by the air compressor does not fill the space L instantaneously when the ports E open the ports H.

The pressure in the space L once established by the movement of the control handle on the bridge, has to be maintained constant until the speed of the ship is next altered. If the pressure leaks it has to be made up. This process is looked after automatically by the design of the valve. Thus if the pressure in the space L falls the piston F will be pushed over to the right by its spring, thus causing the ports H to open the ports E and admitting fresh pressure from the compressor until the initial state is re-attained. Before leaving this part of the mechanism it may be pointed out that the exact pressure delivered by the compressor is immaterial to the working of the device. So long as the compressor pressure exceeds a certain amount the pressure established in the space L is solely determined by the movement of the plunger C. It may be added that when the control handle is returned to its mid position the pressure in the space L is released to the atmosphere by way of the ports J K.

A practical difficulty has now to be faced. The action of the valve will break down if the leakage loss from the space L exceeds a certain definite rate. Let the control handle A be operated so as to open the ports E H by an area $a$, say. With the more or less constant pressure of the air compressor behind this area there is a definite rate of flow through it. If the leakage area permits of a flow equal to or greater than this flow no pressure will accumulate in the space L and the piston F will not move over to the left. The smaller the area $a$ the less is the permissible leakage, so that if the leakage is excessive the valve, while working satisfactorily on the control of the higher speeds, would fail when set to give speeds in the region of "dead slow."

For this reason it is impossible to transmit the pressure established in the space L direct to the engine-room, there to operate the turbine nozzle valves. The loss due to leakage past the piston of the operating cylinder in the engine-room, together with the leakage from the connecting pipes and that past the piston F of the control valve itself, would, under these circumstances, exceed the permissible maximum. Further, the volume in communication with the space L would be considerable and would not be constant, but would vary with the displacement of the piston in the operating cylinder. Both these circumstances would produce a sluggishness in the action of the control.

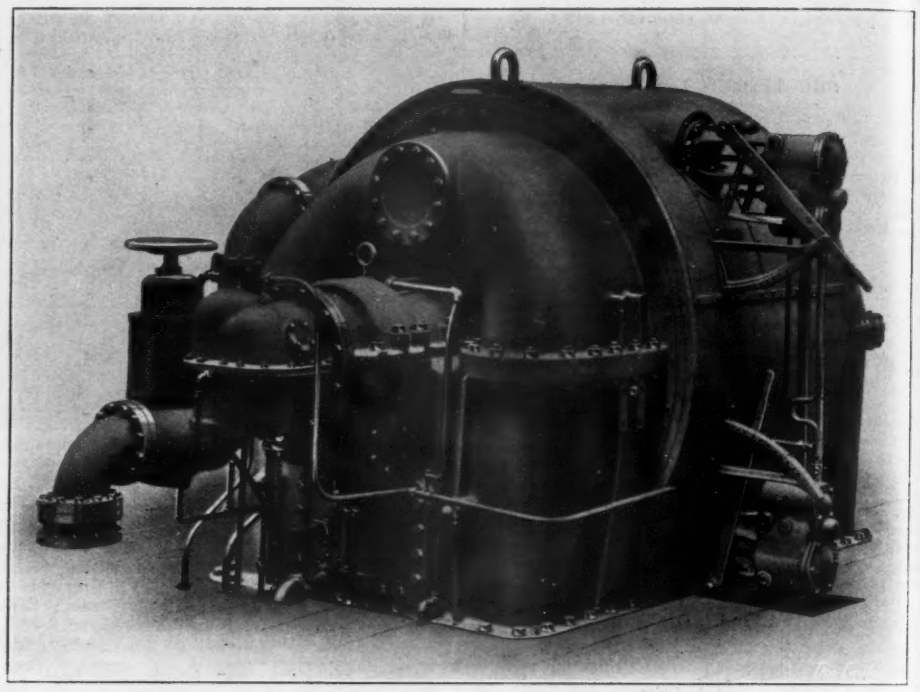


Fig. 4—THE CONTROL CYLINDERS ON THE TURBINE

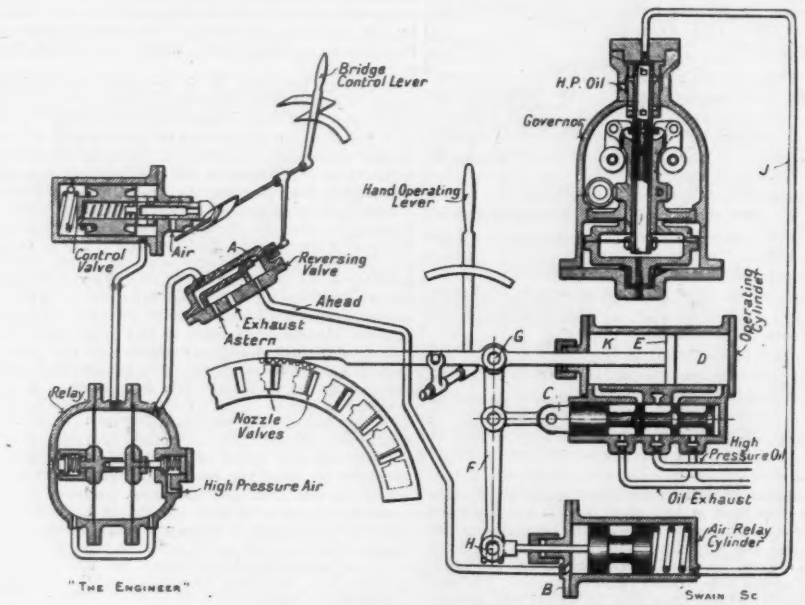



Fig. 3—DIAGRAM OF WESTINGHOUSE BRIDGE CONTROL SYSTEM

It is necessary, therefore, to relay the pressure in the space L to the engine-room and to make the relaying device look after all the leakage loss involved in the connections between itself and the operating cylinder. The control valve—Fig. 1—can make up the leakage produced by itself and involved in the short connections extending from it to the relaying device.

The relaying device is shown in diagram in Fig. 2. It consists of a three-part casing divided into three chambers N P Q by means of two diaphragms R R. The central chamber P is connected by the pipe M with the space L—Fig. 1. The two chambers N Q are connected together by a pipe S so that the pressure at all times is the same in both. Each diaphragm carries a valve. One of these, T, opens and closes the chamber N to the atmosphere, while the other, U, opens and closes the chamber Q to the pressure of the air compressor. A pipe V is led off from the chamber Q to the operating cylinder in the engine-room.

With the establishment of a definite pressure in the space L—Fig. 1—a similar pressure is, of course, established in the chamber P—Fig. 2. Such pressure swells the diaphragms and thereby opens the valve U to the compressor pressure and closes the valve T to the atmosphere. Air from the compressor therefore fills the chamber Q, the pipe S, the chamber N, the pipe V, and the operating cylinder in the engine-room. Just as in the case of the control valve, the inlet of air is throttled and the full pressure delivered by the compressor does not fill these spaces and pipes instantaneously. As it increases in amount it tends to restore the diaphragms to their unstrained state, and when it is just equal to the pressure in the middle compartment the valve U closes and the valve T opens. It will be noticed here that as the valves are balanced the effective areas on each side of the diaphragms are equal.

Thus as soon as the pressure in the chambers N Q and the connecting pipes reaches equality with the pressure in the chamber P it is released. No sooner is it released, however, than the valve U opens again and the valve T shuts. The pressure in the chambers N Q again rises only again to fall, and so on. In practice the movement of the valves is very slight and very rapid, and the net result is the maintenance in the chambers N Q, &c., of a pressure identical with the pressure in the chamber P and varying through an imperceptibly small range.

The volume connected with the space L—Fig. 1—namely, the volume of the pipe M and of the chamber P—Fig. 2—is thus constant at all times, except for the minute "breathing" of the diaphragms. Further, the relaying device will make up any loss of pressure occurring through leakage between itself and the operating cylinder. In addition, its action is such that as the piston of the operating cylinder is being displaced and the volume to be filled is increasing, the piston is followed up by a substantially constant pressure identical with that established in the space L—Fig. 1. The transmission, therefore, from the control handle to the engine-room is practically instantaneous and is unaffected by the leakage which is bound to occur.

The further course of the transmission may be followed from the complete diagram of the system given in Fig. 3. From the relaying device the air passes first to a reversing valve A—Fig. 3. Before the control handle on the bridge

can be pushed into the astern quadrant it has to be displaced sideways in a slot. This sideways movement operates the reversing valve and thereby switches the control off the ahead nozzles on to the nozzles of the astern turbine. The ahead details are shown in Fig. 3. The astern details, being similar, are omitted.

From the reversing valve the air pressure established in the relaying device is taken, not to an operating cylinder in the engine-room, as we have implied above, but to a relay cylinder B—Fig. 3; see also Fig. 4. The piston of this cylinder is pushed back until the air pressure is balanced by the compression of a spring. This movement induces a proportional movement in the same direction in a piston valve C. Oil under a pressure of about 65 lb. per square inch is thus admitted into the space D behind the piston of an operating cylinder and the opposite end of this cylinder placed to exhaust. The piston E thereupon moves to the left and, being connected to the nozzle valve ring as shown, opens the nozzles.

The fulcrum of the lever F has now changed from the pin G to the pin H. As the piston E moves to the left, therefore, it pulls the valve C over with it. When this valve has closed the oil ports the movement of the piston E, of course, ceases, and all the details from the control lever to the nozzle valves take up their desired positions.

Our description of the events that occur applies to the case of starting the machinery from rest or of increasing the speed. When it is desired to reduce the speed or to stop the process is just reversed. The exhaust from the space L of the control valve and from the chamber P of the relaying device takes place through the ports J K—Fig. 1. The exhaust of air from the relay cylinder B—Fig. 3—and its connected spaces takes place past the valve T—Fig. 2.

Should the speed of the turbines tend to rise above that ordered from the bridge—as by the racing of the propellers—a governor is arranged to come into action. So long as the speed of the turbines is in accordance with the setting of the bridge-control handle the pipe J—Fig. 3—is filled with oil at atmospheric pressure. If the speed rises above the desired amount the governor admits high-pressure oil to this pipe, the pressure of which, acting on the right-hand end of the piston in the cylinder B, pulls the valve C over to the left. Oil is thus admitted to the space K of the operating cylinder, while the space D is placed to exhaust, and as a result the nozzle valves are partially closed until the speed of the turbine falls again to the prescribed amount.

An example of this bridge control, together with other exhibits representing the application of certain products of the Westinghouse Machine Company to marine service, is, we understand, to be shown at the forthcoming Shipping, Engineering, and Machinery Exhibition at Olympia.

## THE ROYAL COMMISSION ON RAILWAYS.

### No. XIII.*

ALL the members, except Mr. Jackson, were present at the meeting of the Royal Commission on the afternoon of Thursday, the 14th inst., when two witnesses were heard, the first of whom was Mr. F. D. Williams Drummond. Mr. Drummond is interested in the Llandilo and Lampeter Light Railway, 23 miles in length. The Light Railway Commissioners held their inquiry in 1905, and the Board of Trade confirmed the Order in 1908.

The railway has not, however, been begun owing to the restrictive conditions laid down in the Acts of 1896 and 1912. Under the Act of 1896, Sec. 4, Sub-section 1, no loan is available from the Treasury unless at least one-half of the total amount required is provided by means of share capital, and one-half of this amount must have been subscribed and paid up by persons other than local authorities. Under the Act of 1896, Sec. 5, Sub-section 1, as amended by the Act of 1912, Sec. 5, Sub-section 2, a grant could be obtained from the Treasury if an existing railway company had undertaken to work—under the Act of 1896 it was "to construct and work"—the railway. But owing to the refusal of the Great Western and London and North-Western companies to do this the light railway could not either raise the one-half of the capital to get a loan nor could it get the grant. These companies said that the railway would not be remunerative, but witness believed that they did not like the line. It connected at Llandilo the Vale of Towy joint line of the London and North-Western and Great Western with what was the Manchester and Milford, but now part of the Great Western at Lampeter, south of Aberystwyth, across a country without railways. At present the traffic was taken *vid* Ferryside, three times the distance. There was already a light railway from Lampeter to Aberayron, and this was being worked by the Great Western.

The stumbling block was the Sub-section 1 of Sec. 4 of the Act of 1896. This should be amended so that the prescribed amount of outside capital might be less. The company could not get a grant under the Development Act as the railway would be trading for profit. The railway would be of standard construction with 75 lb. rails.

In answer to Mr. Prothero, the witness said that he believed that only two light railways in England had obtained a grant, and they had succeeded, he thought, by the contractors meeting the financial conditions. If there were a loss, Mr. Drummond thought that the Treasury should make it good, but, on Mr. Prothero's suggestion, he agreed that the local authorities might give aid from the county, and possibly from the district, rate.

Sir Frederick Upcott made what we thought a very valuable suggestion, which was that the main companies should not be asked to send through traffic over the line. This would save them from the loss on that traffic, and so remove their objections to the line.

Mr. Edmund Stirk, of Halifax, followed, but there was nothing new in his evidence.

On Friday, when the Commission was complete, except for Mr. Shackleton, three witnesses were heard. The first was Mr. E. H. Beckwith, of Pickford and Co., Limited, general carriers, who gave as an illustration of the need for a cheaper tribunal, his company's case against the London and North-Western Railway. This started in the Railway Commission Court in July, 1903, but judgment was not given in the Court of Appeal, where the case went, until May, 1907. Lord Loreburn remarked that this was the first complaint the Royal Commission had had as to the law's delays. Witness said he was not complaining of the Railway Commission, but instanced the case as showing the difficulties of dealing with such a small matter as was in question, *i.e.*, the amount due to Pickfords as a rebate for cartage. Mr. Beckwith also wanted the cheaper tribunal recommended by Mr. Russell Rea's Committee, and for the rate books to show "station to station" rates in all charges and the charges for other services.

Witness was strongly opposed to nationalisation. "I cannot put this point too highly," he said. British railway services were very effectively rendered, and he really had no complaints to make. Under State ownership the quick goods service would probably be withdrawn, claims might not be recognised and credit accounts would be closed. The delays experienced in France and Germany were unknown here, and he had to allow considerably more time for consignments on the Continent. He would welcome any closer arrangements between English companies, so long as the trader was protected.

Mr. F. Warner, of the Silk Association of Great Britain and Ireland, asked for a modification in the Carriers' Act, passed in 1830, whereby silk is regarded as an article "of great value in a small compass," and had to be specially dealt with as a consignment. Witness admitted that this was a case for parliamentary action. He also said that through the good offices of the Board of Trade a conference with the railway companies had been held and concessions were likely to result.

The last witness was Mr. F. Parker Rhodes, of Rotherham, the chairman of the Association of Private Owners of Railway Rolling Stock. He said that he appeared before the Commission to make sure that in any change that might be made in the ownership or working of English railways provision was made to secure to traders the right to have their own rolling stock. He also asked that when a trader's wagon was delayed in transit a rebate should be given.

The great majority of Mr. Rhodes' friends were opposed to nationalisation; it would be bad for the trader and bad for the country. Generally, the facilities afforded by English companies were equal to those found elsewhere. The railways had done great good for the country. His only complaint against them was that they did not keep their undertakings up to the mark and only made improvements when they were actually needed. But, after all, said the witness, railways are not the only people who do that.

The Commission then adjourned until yesterday—Thursday—afternoon.

* No. XII. appeared May 15th.

## LETTERS TO THE EDITOR.

*(We do not hold ourselves responsible for the opinions of our Correspondents.)*

### SUCTION BETWEEN PASSING AEROPLANES?

SIR,—The disastrous collision in mid-air between two Army aeroplanes at Farnborough on Tuesday of last week, following so closely on a very similar accident at Buc last month, seems to me to raise the question of whether or not "suction" can manifest itself between passing aircraft. The circumstances of the two disasters are noticeably similar. In the French accident one machine was overtaking the other, and when directly over and only a few feet above it, the upper machine was seen suddenly to fall upon the lower. Both fell to the ground and the pilot and passenger of the overtaken machine were burnt to death. In the English disaster the conditions were almost identical. The two machines involved had previously been noticed to be flying remarkably close together. Suddenly the upper machine was seen to dive downwards while the lower appeared to shoot upwards. They met with a crash and fell to the earth. The pilot and passenger of the lower machine lost their lives, but the pilot of the upper, like the pilot and passenger of the upper machine at Buc, escaped with severe injuries.

Since the Hawke–Olympic collision most people have come to the conclusion that "suction" can be manifested between passing vessels, and that it can reach a magnitude beyond the power of the helm to control. It would be extremely curious—indeed, it would strike one as almost anti-physical—to find that there was no similar phenomenon of suction between two passing airships. In fact, the probability of there being such a suction is so strong that we can, I think, safely say that the problem to be considered is whether or not the magnitude of the suction can become sufficient to overcome the means of controlling the airships, and whether or not, and, if so, to what extent, a similar phenomenon is to be expected between passing aeroplanes.

I recently watched a certain distinguished scientist blowing large soap bubbles, and was much struck with the obvious difficulty he had in fanning a bubble out of danger when it approached within a certain distance of the walls of the room. He strove to do so by creating an upward draught between the bubble and the wall, and although he fanned vigorously he was as often unsuccessful as otherwise. Indeed, at times it certainly appeared as if the fanning were actually assisting the bubble to disaster. I overheard him remarking that there seemed to be an "extraordinary attraction" between a soap bubble and certain objects, but the thought arose in my own mind that it was a case of "suction" pure and simple. A similar experiment conducted with two soap bubbles or with two toy balloons filled with coal gas would be instructive to watch.

While these observations clearly apply to dirigible balloons, their application to aeroplanes is not direct. On this point, however, the results of certain carefully conducted experiments on the influence of the planes of a biplane on one another seem to have a very illuminating bearing. Given two superposed planes, whether the two planes of a biplane or the planes of two adjacent but separate machines, what is the effect of the one on the other? Experiments made by M. Eiffel, at Teddington, and elsewhere indicate the answer quite clearly. It is indisputably established that one plane does exert an influence on the other, and that the closer together the planes are brought the greater is this influence. The reason is obvious. The upper wing directs a current of air downwards into the vacuum in the neighbourhood of the upper surface of the lower plane—a vacuum on which quite two-thirds of the lift of the lower plane depends. Conversely this vacuum extending upwards is bound to affect the pressure on the underside of the upper wing and therefore reduce the lift. The joint effect is a reduction in the combined lift of both planes. M. Eiffel has found that for two cambered wings spaced at a distance apart equal to the length of the wing chord the reduction of the lift is equivalent to a loss of 23 per cent. or so in the effective area of the wings arranged in the monoplane manner.

It may be argued that this effect cannot be called "suction" as we understand it in the case of two passing vessels. I would suggest, however, that the difference is merely one of definition. The reduction of pressure on the underside of the upper wing and the reduction of vacuum on the topside of the under wing could be produced in the wings when separated by decreasing the relative velocity of the air past them. We seem, therefore, entitled to say that the loss of effective area in a biplane arrangement is due to a reduction in the velocity of the air in the space between the wings.* In the case of suction between passing vessels the attraction is, of course, produced wholly or in part by an *increase* in the velocity of the water in the space between them.

It is extremely unfortunate that neither the National Physical Laboratory nor M. Eiffel, nor anyone else so far as I am aware, has investigated the wings of biplanes separately. They have all confined themselves to discovering the loss of combined lift and do not inform us how much of this loss is to be attributed to the upper plane and how much to the lower. If both lose equally, then my argument, I must admit, fails entirely, for when we apply the results to the case of two superposed machines we would have to conclude that if they fell at all as the result of their interaction they would fall at equal rates. Collision in mid-air would therefore not occur from this cause unless one pilot, feeling himself falling, tried to elevate his machine—a by no means unlikely occurrence.

We are not, however, entitled to suppose without experimental evidence that the loss of lift is equally distributed between the two wings. Indeed, it is much more likely, I think, that the lift of one is interfered with more than that of the other. The vacuum on the back of a wing contributes quite two-thirds of the total lift. It may be hazarded, therefore, that the vacuum of the lower wing upsets the lift of the upper wing to a greater extent than the pressure of the upper wing upsets the lift of the lower. In the case of two superposed machines I would therefore expect the upper to suffer a greater loss of lift than the lower. I am strengthened in this opinion by the fact that in both the English and French collisions it was the fall of the upper machine on to the lower that apparently precipitated the collision.

I put this theory of suction between aircraft forward with reserve, and only desire to point out the possibility of its being the cause or a contributory cause of aeroplane collisions. As to whether two aeroplanes can approach one another in mid-air sufficiently close to produce the effect I have spoken about, and as to whether a loss of effective area of something between 11¼ and 23 per cent. is sufficient to produce disaster under the stated conditions, I will express no opinion. I desire, however, to commend the matter to the further discussion of aeronautical experts, and particularly to those engaged on the experimental side of the science.

AEROFOIL.

London, S.E., May 18th.

* This opinion is apparently shared by Messrs. Short Brothers, as the reader may gather by turning to the last page but one of this issue.—ED. THE E.

### METAL *v.* WOOD FOR AEROPLANES.

SIR,—In connection with the disputed question of the relative merits of wood and steel in structures which are liable to vibration, an interesting comparison is possible in the case of wheels.

In artillery wheel practice, where absolute reliability combined with a reasonable degree of lightness is essential and where the stresses are more severe than in any other form of timber structure, wood only is found to give satisfaction—usually ash or sissoo.

I believe I am right in stating that at the period of the late South African war six batteries of artillery were ordered from a German firm. These batteries were fitted with the latest steel wheels. In less than three months of actual use these wheels had to be scrapped and wooden wheels substituted, because these steel wheels were unable to withstand the vibrational stresses set up in them. Incidentally, the ordnance factories must have a regular museum of steel wheels.

Aeroplanes are undoubtedly subject to continuous vibration when in flight, although such vibrations are not so severe in character as those in artillery wheel practice would be, but the period of such vibrations would be greater.

What the aviator wants is security from mishap whilst in the air. A small flaw in the interior of a steel tube is practically impossible to detect; but any flaw in a timber scantling shows itself at once by a variation in the direction of the grain of the timber for some distance around the exact position of the flaw.

Thus, apart from its greater resilience in withstanding shocks, and its greater power of the absorption of vibration, timber would appear to be the safer material for use in plane construction.

O. PAUL MONCKTON.

London, S.W., May 15th.

## LAUNCHES AND TRIAL TRIPS.

ARUM, cargo motor vessel; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Flower Motor Ship Company, Limited, London; dimensions, 350ft. B.P. by 47ft. by 27ft.; to carry 6000 tons; the vessel is fitted with twin-screw Diesel motors of the Polar type working on the two-cycle principle with four working cylinders on each motor, and developing 1150 brake horse-power; built by Swan, Hunter and Wigham Richardson, Limited; a speed of 10¾ knots was attained on trial trip, May 7th.

VAN DER DUYN, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of Messrs. Wambersie and Zoon, of Rotterdam; dimensions, 343ft. by 45ft.; to carry fruit from West Indies and Central America; engines, triple-expansion; constructed by North-Eastern Marine Engineering Company, Limited; launch, May 7th.

URAWANA, twin-screw passenger steamer; built by Phillip and Sons, Limited, Dartmouth; to the order of Crown Agents for the Colonies for British Guiana; dimensions, 100ft., 25ft., and 9ft.; to carry passengers and cargo; engines, two sets compound, surface condensing, pressure 140 lb. per square inch; launch, May 9th, 1914.

LEVNET, steel screw single-deck steamer; built by Ropner and Sons, Limited; to the order of the Gordon Steam Shipping Company, Limited, London; dimensions, 351ft. 6in. by 48ft. 6in. by 24ft. 4in.; to carry cargo; engines, triple-expansion, pressure 180 lb. per square inch; constructed by Blair and Co., Limited; launch, May 11th.

CORINTHIC, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Messrs. W. H. Cockerline and Co., Hull; dimensions, 400ft. by 52ft. by 29ft. 6in.; to carry 8000 tons; engines, triple-expansion, 25½in., 42in., and 70in. by 48in. stroke, pressure 180 lb. per square inch; constructed by Richardsons, Westgarth and Co., Limited; launch, May 11th.

RUFFARD HALL, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of Ellerman Lines, Limited; dimensions, 420ft., 53ft., and 32½ft.; engines, inverted direct-acting triple-expansion; constructed by the Wallsend Slipway and Engineering Company, Limited; launch, May 12th, 1914.

SPRINGWELL, steel screw steamer; built by Wood, Skinner and Co., Limited; to the order of the Well Line, Limited, Newcastle; dimensions, 425ft. by 54ft. by 33ft.; to carry cargo, London–Calcutta trade; engines, quadruple-expansion, 25½in., 36in., 52½in., and 76in. by 54in. stroke, pressure 220 lb. per square inch; constructed by North-Eastern Marine Engineering Company, Limited; trial trip, recently.

## A NEW AIR COMPRESSOR.

THE ordinary form of Reavell quadruplex compressor is now fairly well known, but in these days of strenuous competition, no firm can afford to rest on its laurels, and "Progress" must be the watchword of all who wish to maintain their position. Good though the original compressor was in eliminating the suction valves, Messrs. Reavell have now gone a step further and managed to design a compressor which has no valves at all in the ordinary sense of the word. All those who have had to deal with air in large volumes or at high pressures know what that means. How this has been effected will be clearly seen by reference to the drawing of the compressor cylinder—shown in Fig. 1. Here the hollow gudgeon pin, as before, acts as a suction valve, the ports therein being closed and opened as required by the oscillation of the head of the connecting-rod, and air is compressed in the cylinder A by the rising of the piston B; in this case to a pressure of 10 lb. per square inch. It is at this point that, owing to the disappearance of the delivery valves, which were equally arranged in a ring round the top of the cylinder A, the alteration in design commences. Attached to the main piston B is what is termed a pilot piston P, the centre of which is hollow, and serves as a passage for the air delivered from the cylinder to the main delivery belt.

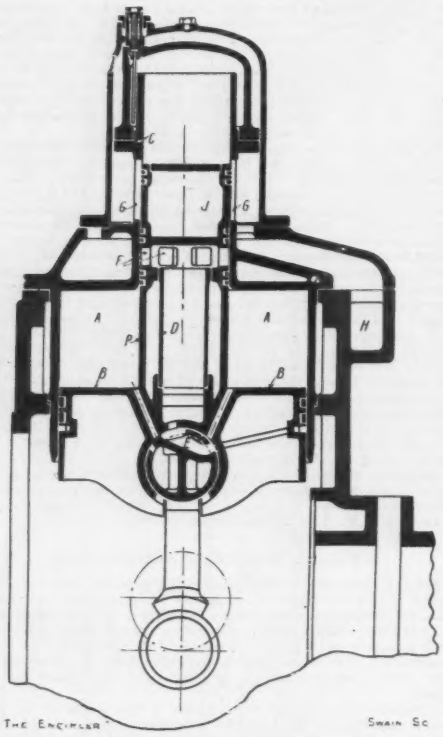



Fig. 1—SECTION OF COMPRESSOR CYLINDER

The compressed air instead of, as previously, passing out of the delivery valves, now passes out at the bottom of the cylinder, through the passage E in the gudgeon pin and up the centre of the pilot piston. From there, when the piston has risen high enough, it passes out of the ports F into the chamber G, and so into an air belt H, which is common to all the four cylinders of the compressor unit. Meanwhile the upper part of the pilot piston J has entered the cylinder E and entrapped therein a certain amount of air which forms a cushion and so keeps the pressure always on the top side of the gudgeon pin. The exact volume of this chamber, of course, requires careful calculation in order that the compression may be sufficient to keep the pressure on the pin without putting unnecessary work on the compressor. In the lower two of the four cylinders drains are fitted to this chamber to prevent an accumulation of oil or water. Several points of interest arise out of this method of construction. The most important of all is the entire elimination of valves, so that the water jackets can be kept clear of obstructions, and the flow of water should be even and well distributed over all the surface.

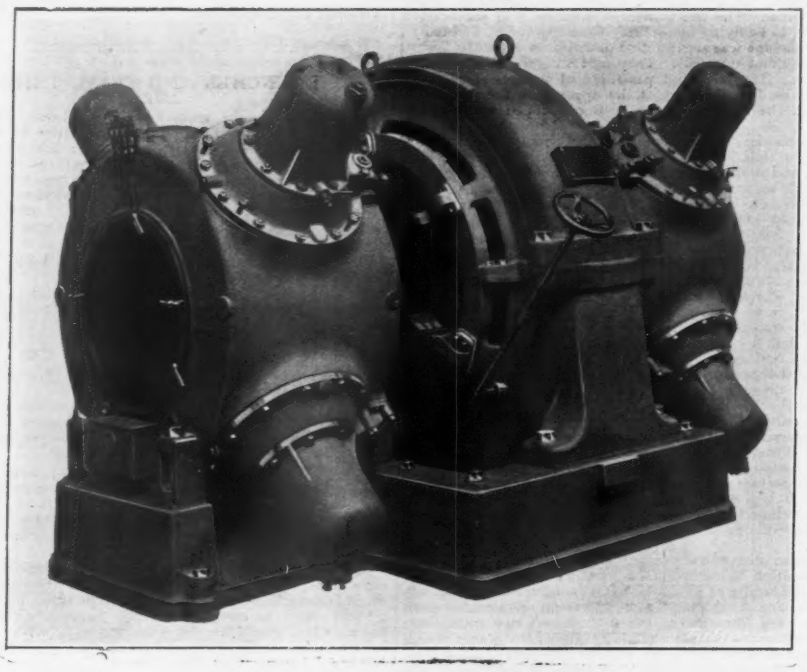


Fig. 2—ELECTRICALLY-DRIVEN AIR COMPRESSOR

The particular installation with which we propose to deal is one built by Messrs. Reavell for Mr. J. M. V. Money-Kent, and is to be used for providing air for converters, where the pressure required is only 8 lb. to 12 lb. per square inch. With the ordinary form of compressor for low-pressure air the amount of work wasted in simply lifting the valves forms a very high proportion of the whole, whereas with this valveless form there is no such loss, which, in addition to the reduction in the clearances, allows the size of the plant to be decreased. These two factors, with the help of a nice piece of designing work, have resulted in what we think must be about as small a piece of machinery for its output as can well be imagined.

The compressor cylinders are arranged in sets of four at 90 deg. to each other in the ordinary quadruplex manner, and two sets are used in the one plant, so that there are eight cylinders, and the air is divided up into eight streams, which can more effectively be cooled than in the case of an ordinary compressor with one or two cylinders.

The method of mounting the compressors is clearly shown in Fig. 3, and there are some nice little points about this. The crank shafts of the compressors are exactly alike, and instead of being coupled together by a short length of intermediate shafting to carry the armature spider of the motor for driving them, the ends of the shaft are brought close together with only a small intervening space, and the armature is mounted on these two shafts; thus the main bearings of the compressors serve also to support the weight of the armature, and great compactness results. The method of attachment of the armature to the two pieces of shafting is very clever. Each of the shafts has a cone upon it which fits into a corresponding cone bored in the armature boss, the end portion of the shafts being parallel and bearing on a parallel portion in the centre of the boss. Split rings R R are bolted together over the shafting, and in these rings are fitted drawing-in studs by which the cones can be drawn tightly up and held in position, the actual drive being taken by the keys shown. If the casing of the compressor had been made in two parts split through the bearing, the ring R could, of course, have taken the form of a collar turned solid on the shaft.

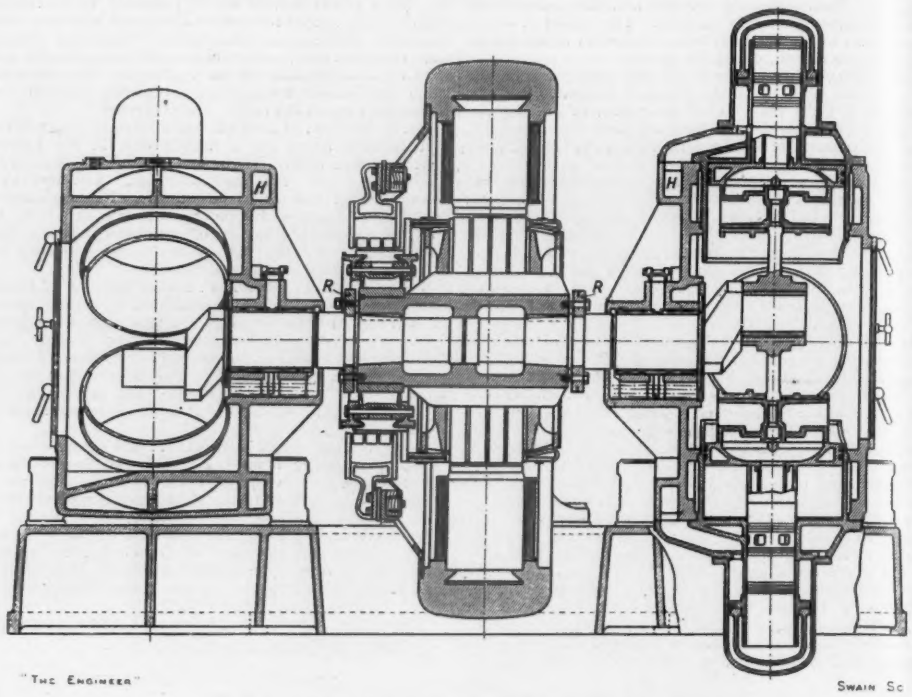



Fig. 3—SECTION THROUGH COMPRESSORS AND MOTOR

The two compressors are mounted on a heavy cast iron bed with the motor in between, and, as we say, it makes a wonderfully compact little plant, considering that it has to deliver 2500 cubic feet of air at 250 revolutions per minute. At that speed the compressors run very quietly, much more so than the ordinary valve type, as is natural. It is hardly fair to judge of the vibration, as on the occasion of our inspection the set was only mounted on a couple of angle iron girders. The air is collected from the belt, which runs right round the compressor castings, and passed into the delivery piping; in the event of the compressor delivering into a receiver, a non-return valve is fitted in this piping, the necessity for which, we learned, is that if the electric motor is stopped the air pressure would drive the compressors round as an air engine. In this particular plant, however, no receiver is fitted, and therefore no non-return valve is needed. There is also a by-pass valve in the piping which, when the compressors are delivering too much air, allows the whole of the output of one of the compressors to exhaust into the atmosphere, though we must admit we hardly see the need for this, as the plant will run very slowly.

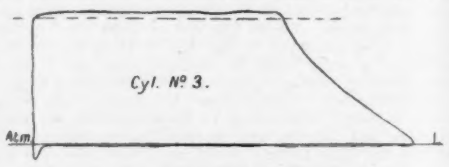



Fig. 4—INDICATOR DIAGRAM

The indicator card, which we are able to show in Fig. 4, is very interesting, as showing an almost entire absence of wire drawing and a very good compression line.

## EDUCATIONAL INTELLIGENCE.

A COURSE of lectures on "Industrial Hygiene" will be delivered by Professor Sir Thomas Oliver, M.A., M.D., LL.D., F.R.C.P., F.R.S. (Ed.), Professor of Medicine in the University of Durham College of Medicine, Newcastle-upon-Tyne, in the lecture room of the Royal Institute of Public Health, on the dates given below. The fee for the course will be one guinea. Syllabus:—Lecture No. 1, Wednesday, May 27th: The Rise and Progress of Factory Legislation. Lecture No. 2, Thursday, May 28th: Injurious Occupations—(*a*) Fumes: Melting and Pouring of Metals; Lead; Zinc; Brass. (*b*) Dust: Pottery; Printing, &c. (*c*) Gas: Occupational Poisoning by Gas; Carbon Monoxide; Sulphuretted Hydrogen and Use of Explosives. Lecture No. 3, Wednesday, June 10th: Coal Mining: Its Risks to Life and Health. Accidents, Explosions, Dust. Lecture No. 4, Thursday, June 11th: Gold Mining and Diseases of the Lungs. Lecture No. 5, Wednesday, July 8th: Ankylostomiasis. A Newly Added Danger to Mining at Home and Abroad. Lecture No. 6, Thursday, July 9th: The Passing of Great Industries or How Dangerous Trades have been Rendered Comparatively harmless Occupations. Lucifer Match-making and the Silvering of Mirrors.

# FAILURES OF HEAVY BOILER SHELL PLATES.*

By SIDNEY A. HOUGHTON.

In spite of the fact that the knowledge of the manufacture and science of steel making increases year by year, as shown by the *Journal* of the Iron and Steel Institute, it is unfortunately true that failures of plates which have passed the usual tests are not yet eliminated. That this should be the case with the lower grade descriptions of mild steel would not give cause for criticism, but that they should occur with the heavy boiler shell plates used in marine boilers, which are made from the highest class of mild steel, and generally from special charges, is a matter which is worthy of special investigation. The only paper on the subject seems, however, to be the able one by Mr. J. T. Milton, Chief Engineer of Lloyd's Register, on "Fractures on Large Steel Boiler Plates," which is given in the "Proceedings" of the Institution of Naval Architects.† This paper is of considerable importance, but practically deals fully with only one case, which was investigated by Professor Arnold, though four or five others are described.

The importance of failures of this nature has long been recognised, and careful investigations have been made by the Board of Trade and the Classification Societies into fractures discovered in the boiler shops, but as financial questions often arise between the steel maker and the boilermaker it is not as a rule possible to publish the results at the time, and indeed in some instances the actual causes have not been definitely ascertained.

The cases described in the present paper are selected from those which have come under the author's notice during the last fifteen years. Some of the plates were not under Board of Trade inspection, but through the courtesy of Lloyd's Register of Shipping and the British Corporation for the Survey and Register of Shipping facilities were afforded for testing and examining the plates in conjunction with their surveyors.

It should be stated here that the plates had all been tested in the usual way, at least one tensile and two bend tests being taken from opposite corners, and in some instances from each corner, and that the results were satisfactory; also that the plates were bent cold in the rolls to the necessary radius, and that all rivet holes were drilled in place.

The principal details of the failures are given in a table [not reproduced.—ED. THE E.] and a description of the circumstances attending them is given before considering the causes of failure as a whole. It must be understood that the opinions as to the causes of failure are those of the author and are not necessarily those of the Board of Trade or of the Registration Societies concerned. In some instances the conclusions arrived at cannot be fully verified; but the author hopes that by thus publishing them it will be possible to obtain criticisms and suggestions which will lead to the discovery of the correct ones.

All the plates were made by the acid open-hearth process with the exception of plate C4, which was made by the basic open-hearth.

The cases considered are not dealt with in chronological order, but are divided into three classes as follows:—

(A) Plates in which partial cracks only have occurred.
(B) Plates which have cracked right across in the boiler shop.
(C) Plates which have failed under the hydraulic test.

*Class A.*—In most of the plates of this class the cracks have occurred in dressed portions, and hammering has been one of the chief causes of failure, though many plates are abnormal in some other characteristic. It is hoped that this list of failures may help to prevent the use of this obnoxious practice in future.

A1.—This plate had some well-marked surface defects, accompanied by an absence of carbon near the surface, possibly due to the slab being burnt in the soaking pit; the surface has been well hammered, and it is not surprising that the steel in this part gave way when bent. The structure near the centre was very coarse, and is in great contrast to that on the outside, which may be due to the slab not being uniformly heated. There is considerable difference between the original tests and those in the vicinity of the fracture, and as the analysis does not agree with the latter, it is probable that the drillings were taken from another place and that the plate was far from uniform in composition, though it should be mentioned that there is no sign of segregation in the sections examined.

A2.—Both the sulphur and phosphorus were very high in this plate, and the latter formed some carbonless bands near the surface, thereby helping to cause roughness and conferring extra brittleness on the part which was hammered. This metal contained a great number of blowholes which increased towards the centre, and it may be remarked that in several instances an excessive number of blowholes appear to indicate an inferior quality of metal, though at first sight there seems no reason why any material difference should be noticeable if the metal is stressed in the same direction as that in which it is rolled. The general structure is very lamellar in character, which it is suggested may be produced if the slabs are soaked too long, especially when the phosphorus content is high. The failure of this plate was due to hammer dressing on surface defects produced by the minor segregations of phosphorus.

A3.—The primary cause of the failure of this plate was probably a large carbonless area due possibly to the surface of the slab being burnt or decarbonised in parts; there are also some carbonless bands below caused by phosphorus segregations. There were no signs of hammer dressing on this plate.

A4.—The structure of this plate was extremely lamellar and there were an excessive number of blowholes. The phosphorus was quite high enough and there was a considerable amount of arsenic; the plate was also hammer dressed, but there were no signs of segregation near the fracture.

A5.—This plate shows a structure considerably different from the preceding cases; it was said to have been annealed, but if so the annealing was very inefficient. The general structure was very fine and mostly lamellar; in fact, too small to be produced by annealing, and the plate must have been finished at a very low temperature, thereby setting up internal stresses.

A6.—The defect in this plate was only found under the hydraulic test when a leak was observed near a rivet hole; and on further examination it was seen that there was a crack starting from the rivet hole in a dressed part. This crack did not go right through the plate, and was only shown by the water passing round the rivet itself. The length of the crack was 17¼in. and the depth 1¼in., and it was of the "bubble" description. The tensile tests were satisfactory, but the structure shows that the plate was finished at a high temperature, probably not less than 800 deg. Cent., and that the plate had been hammered in the dressed part to conceal a surface defect.

A7.—This plate was partly riveted into the boiler, when it was found that there was a transverse crack 13in. long, extending from one of the rivet holes, this being in a part of the plate which had been dressed. The tensile tests taken near the crack gave satisfactory results, with the exception of one which failed with an extension of only 4 per cent. due to a concealed surface defect. The bend tests were similarly good, except one taken alongside the crack which failed from a surface defect. The analysis gave nothing unusual, though the phosphorus was somewhat high, whilst the microscope showed that the structure was fairly normal, but that the surface had been severely hammered to conceal surface defects arising from the outside of the slab being overheated.

A8.—This plate had been curved to radius when an irregularly shaped crack about 8in. long was noticed in a dressed part. On the piece containing the fracture being broken the crack was seen to be very uneven in character, extending to about half the thickness of the plate. The tensile and bend tests were satisfactory, except bends made from the dressed portion, which failed at a small angle. Analysis showed that whilst the carbon decreased towards the surface the phosphorus increased, and this latter condition showed itself as usual as carbonless bands. There were also some blowholes at the surface which had been severely hammered. The internal structure differed considerably from that at the outside, being of a marked lamellar character, and was decidedly coarse for the thickness of the plate.

A9.—This plate had also been curved to radius before a crack 4in. long was found in a dressed part near one side. No tensile tests were taken, but bend tests were made from the dressed portion. These all failed at a comparatively small angle, and it is evident that this test is a simple and efficient one for disclosing surface defects which have been hammered. The analysis is fairly normal, but the microscope showed some large flaws and carbonless bands near the surface. The latter had been hammered apparently with a flogging hammer, judging by the distortion produced, and it was a foregone conclusion that a plate so treated would fail when bent.

A10.—Two cracks in dressed portions of this plate were observed after it had been bent to radius, one being near the end and the other about midway along one of the sides, the latter crack being exceptional in that it was of a rectangular character, one part being transverse and the other longitudinal. Bend tests from the dressed portion failed, and a section near the rectangular crack revealed the nature of one of the defects which it had been attempted to hammer down. This was evidently caused by some foreign substance which had been rolled in, and produced the depression. The structure was deformed by hot work and the top surface had been hammered. There were, in addition, some carbonless bands and flaws near the surface, and, though it sounds paradoxical, there was an increase of carbon towards the surface, there being no signs of segregation.

A11.—The cracks in this plate were not discovered till the boiler was ready for the hydraulic test, when two were seen, one 8¼in. and one 9in. long, in dressed parts not far from the middle of the plate. After the plate had been removed a portion was cut off and broken through the 8¼in. crack, which was then seen to be of the "bubble" description. The tensile tests gave varying results, and showed that the plate was segregated, but all the bend tests were satisfactory. The analysis showed excessive carbon and phosphorus, and indicated that the material was unsuitable for a shell plate. In preparing the sections for the microscope it was noticed that the metal was soft and powdery to the file, similar to that of a steel casting, and on examining the structure this was found to approximate to that of an imperfectly annealed casting, showing that the plate had been rolled at a grossly excessive temperature. This plate was also hammer dressed, possibly in order to hide defects due to the surface being burnt. The following abnormal features occurred in this plate:—Excessive rolling and finishing temperature, excessive carbon and phosphorus, hammer dressing, and central segregation, so that its failure was not a matter for surprise.

A12.—When this plate was being bent in the rolls a tinkling noise was heard, and on examination two cracks were found in a dressed portion, one 3¼in. and the other 1¼in. long. This part of the plate was cut out and broken, when it was seen that the principal crack was of the "bubble" description, so that it would seem that this form of crack can be produced by bending the plate. The transverse tests taken in the vicinity of the cracks all gave poor results, and some failed with a square fracture and a white line indicating segregation. The structure of the plate shows a large number of minute sulphide of manganese flaws, which increased towards the centre both in size and quantity; it seems that the fissures shown on the fractured surfaces were due to this and not to piping. From the microscopical examination it is probable that the amounts of carbon and sulphur given in the analysis are under-estimated.

A13.—In this instance a crack about 8in. long was found in a dressed portion of the plate near the centre. The analysis obtained was normal and the mechanical tests were satisfactory. The structure showed heavy blowhole and surface flaws, with carbonless bands near the surface, which had been hammered. The general structure was very coarse, indicating high temperature of rolling and slow cooling, and possibly this plate had been piled.

*Class B.*—The failures in this class are in some respects of a more important character than those already considered, as the plates failed by cracking right across in the rolls, giving the impression of extreme brittleness.

B1.—This plate had only partially been bent to the required radius when it broke nearly across, there being two cracks in approximately the same line, which were only separated by a small web of metal. The tensile tests from this plate all gave good results, and the chemical analysis is not abnormal, except that the quantity of phosphorus is high and greater at the outside than in the inside. The structure of the steel showed an excessive number of blowholes, so that before etching the metal looked in parts more like wrought iron than steel. As might be expected from the analysis, there were also considerable local segregations of phosphorus at the outside, and, considering their amount and well-known want of ductility, they probably constituted the principal cause of failure. The plate was also rolled hot on one side, and on examining the sections at the fracture after light etching, lines were seen on the ferrite crystals which were at first thought to be slip bands, but on examination at higher power were found to be Neumann's lines. This plate and B4 are almost the only ones in which the author has seen these lines, and in both cases the metal was hard to the file, more so than would appear from the analysis. It is suggested that the ferrite contained arsenic or some other hardening constituent which was not analysed for.

B2.—This plate cracked right across in the rolls during the first pass. It had been cross rolled, so that the longitudinal axis of the ingot was the transverse one of the plate. The metal generally was of excellent quality, but from the fact that some segregation showed on one side of the plate and blowholes at the other it is evident that too great a portion of the ingot was used. The number of these blowholes was very considerable, and the structure on this side of the plate was of a coarse crystalline character, indicating it had either been overheated when being annealed and possibly piled afterwards, or that annealing had been insufficient to break down the rolling structure; on the whole the former would appear to be the correct opinion. Also at this side the effects of shearing had not been entirely removed by planing, but the structure only appeared to be distorted on the inside of the plate, as the edge had been bevelled as usual. A noticeable feature about this plate was the increase of pearlite on the outer surfaces, and it is suggested that this might be due to the effect of an excessive amount of composition on the ingot mould. In this connection it may be mentioned that heavy carbonisation of the surface may take place in large steel castings when certain carbonaceous coatings are given to the moulds, which fact does not seem to be so widely known as is desirable, and it is worthy of careful consideration by the users of such castings. The increase was comparatively slight in this instance, but would produce an appreciable effect when the plate was being bent. The most striking feature revealed by this case was the great importance of uniform annealing at a correct temperature.

B3.—The carbon content of this plate was too much, indicating that little work was given to the steel; the finishing temperature was very high, and there was considerable difference between the structures on opposite sides. There was also segregation in the centre of the plate and a large number of blowholes near the surface, so that altogether the metal might be described as unsuitable for the purpose for which it was intended.

B4.—This plate broke completely across when being passed through the rolls for the first time, the fracture being of a coarse crystalline character. The tensile tests were, on the whole, satisfactory, only two of the transverse tests showing segregation, which, however, did not reduce the elongation below 24 per cent. The analysis shows high carbon and phosphorus, both being in excess of the amount suitable for mild steel. The chief causes of failure appear to be the formation of a brittle structure combined with unequal annealing and high phosphorus.

*Class C.*—The failures under this heading are the most serious of all, seeing that they imply that the actual factor of safety of the shell was less than two.

C1.—In the first case to be considered the boiler was made with two strakes of plating, and the strake containing the manhole cracked right across through that part, near the minor axis, when the hydraulic pressure had reached 1¾ times the working pressure, although it is said that twice the working pressure had been previously applied. In this plate segregation must have been an important element in producing failure, but probably the principal factor was the presence of internal stresses in the plate. It is difficult to estimate what proportion of these was due to rolling and what proportion to the manhole riveting; but, on the whole, it seems not unlikely that they were about equal.

C2.—In this instance the hydraulic test had reached about 40 lb. below the double pressure when the shell plate gave way at the manhole with a sharp report. The main crack extended from the manhole to one of the rivets in the circumferential seam, and was open $\frac{1}{64}$th of an inch at the manhole and $\frac{1}{16}$th of an inch at the seam. There was a small crack on the other side of the manhole extending only to the nearest rivet hole, and it was noticed that the caulking of the ring was undisturbed. This ring was of the flanged description, which requires a considerably larger opening in the shell than the plain variety, and is more difficult to fit accurately, so that the author thinks that the opening of the plate after the failure was more due to stresses set up in riveting than to any resulting from rolling. It is also more difficult with this form of ring to arrange that the actual compensation approaches the theoretical. The steel of this plate was evidently defective, yet in the author's opinion the causes of this important failure must be considered as largely mechanical, as the segregation did not extend to the crack itself.

C3.—This case is of an exceptionally interesting character, as the plate fractured under the hydraulic test, not through the manhole itself, but through the rivet holes at one end of the ring, the pressure at the time being at a little under twice the working pressure. On the whole, the tests and examination do not show that the metal was sufficiently inferior to cause failure, and it is therefore to a large extent a question of internal stresses, whether produced by rolling or riveting. The fact that the plate failed in a part near the manhole where the strength was but little reduced points to some cause arising from the riveting. The author is therefore inclined to believe that, as will be explained later on, the chief stresses in the plate were produced by riveting the end rivets, and then working from the other end of the ring towards the part where failure took place.

C4.—This plate was made by the basic open-hearth process, and is the one referred to by Mr. Milton in his paper. It will be noticed that the longitudinal tensile tests, even when taken near the fractures, seldom revealed any abnormal features, whilst the transverse tests were far more successful, and so far as tensile tests go, these are certainly the most valuable for ascertaining the inferior parts of steel plates. In nearly all the cases dealt with the bend tests were satisfactory, and at first sight it seems somewhat of an anomaly that a piece of a plate can be bent through 180 deg., whilst the whole plate fractures at a very slight angle. The conditions are, however, wholly different, as in a bend test the metal can flow with little restriction, whilst in the plate very little lateral flow is possible. This fact is of special importance in considering the effect of hammer dressing, as though it is frequently possible to bend a strip of steel after being hammered on the outer surface, it does not therefore follow that hammering a wide plate would be equally innocuous.

In dealing with these cases it is essential to remember that one cause of weakness does not prevent others, and that in general it is the simultaneous occurrence of several defects which results in failure. For instance, it is not sufficient to say that a plate failed because it was segregated; there is little doubt that there are many more or less segregated plates in boilers, but they have not failed as no other diverse conditions were present. A good plan in dealing with a failure is to estimate the percentage value of the different causes producing the fracture, and this has been done in Table I. [not reproduced.—ED. THE E.] but it will, of course, be understood that the values are only approximate estimates. When the total does not reach 100 it means that the author does not consider that all the causes have been ascertained.

In many cases hammer dressing is given as one of the causes, and this is something which one might have hoped would have ceased long ago. Unfortunately, it frequently happens that little hammering saves a good deal of chipping and buffing and the temptation to use the first-mentioned tool is considerable. Moreover, it is almost impossible to detect it if the plate is buffed afterwards, and of this fact the loading bank staff are generally aware, so that very stringent orders and constant superintendence are necessary to prevent it being done. In point of fact the only certain method of detecting it is to examine a section of the plate after fracture occurs, when it is generally plainly evident. The surface defects which necessitate dressing may be only roughness caused by scale being rolled in, or they may be of a more serious nature in the shape of laps, snakes, &c., or due to the local segregations of phosphorus which cause the "ghosts" in forging. The latter are probably the worst defects and must seriously reduce the ductility of the plate as regards bending; they may also tend to give a rough surface in rolling by sticking to the rolls, and will assist in causing corrosion when the plate is in the boiler. The nature and origin of these local segregations have been dealt with by Dr. Stead in a lecture on "Phosphides and Carbides in Iron," and it is to be hoped that steel makers will endeavour to produce ingots for such important plates with a minimum amount; probably the best plan is to keep the phosphorus content as low as possible.

Dressing plates, as now done with an electrically driven emery wheel, is *per se* generally supposed to produce no bad effect, and probably this is true if only the surface is cleaned. If, however, an extensive deep defect, produced, say, by scale being rolled in, is removed, it is quite conceivable that when the plate is bent local stresses are produced, seeing that the resistance to bending varies as the square of the thickness. These stresses may be serious in amount, and in some cases may be even one of the primary causes of failure.

It has been pointed out by Mr. David Colville and others that severe internal stresses may exist in heavy plates, as their stiffness prevents them from buckling in the manner that thin plates do when the rolls are not true, and there is little doubt that this cause is a factor, and possibly sometimes the principal one, in producing failure. Unfortunately, it seems scarcely possible to ascertain the amount of these stresses, or indeed to find out when they exist in a plate in most instances, but it has been supposed by some investigators that the bubble-shaped† crack which so frequently occurs in defective plates is due to this reason. This crack is nearly always at right angles to the direction of rolling, and perpendicular to the surface of the plate. As a rule the surfaces of these cracks are oxidised and are fairly flat, and their depth varies from one-half to three-

* Iron and Steel Institute.—Abstract.
† Vol. xlvii. (1905).

† The shape of the crack is that of a very elongated spirit-level bubble.—ED. THE E.

quarters of the thickness of the plate. It would seem that, if they are the result of relieving internal stresses, the latter reach a maximum at some point below the surface.

In addition to the rolls being actually untrue or having become so when hot, there is also the risk of internal stresses being set up by the plate being subjected to rain through a leaky roof or from having other plates piled on it when hot. The latter must be considered a bad practice in every way, as very serious stresses may be caused through the plates only partially covering each other, so that one part of the plate is almost cold whilst the other is still at red heat, and it is quite conceivable that this cause alone might be sufficient to produce failure. Even if the plate is wholly covered by another it is possible that it may be maintained at the dangerous temperature of 700 deg. Cent. for some time, thereby producing brittleness by partially turning the pearlite into cementite. Owing to the circumscribed space in some works it is difficult to avoid piling altogether, but it would be well that, if it is done, it should be confined to plates which will be afterwards heated in the course of manufacture. In any case, the author is of the opinion that the only satisfactory way to ensure that heavy plates are as free as possible from internal stresses is to anneal them. This will remove the effect of finishing at too high a temperature or too low, and also the results of slow cooling at an improper temperature, and as these evils are not revealed by the usual tests it is the more important to ensure that they do not exist. Although it might seem a simple matter to anneal a mild steel plate, yet experience has shown that there are several pitfalls to be avoided. Even the most suitable temperature has not been definitely settled. One point of importance may be mentioned, which is that mild steels containing a fairly high percentage of phosphorus require very much more drastic annealing than those with a small percentage; it is indeed remarkable how very persistent is the structure of a moderately high phosphorus steel.

It is also of great importance that the whole plate should be raised to the same temperature when being annealed, and although this should be the first axiom in annealing it is not altogether an easy matter to effect with large plates, and some of the older annealing furnaces are not free from suspicion in this respect. Annealing may also be easily abused by soaking a plate to bring its tonnage down, and there are some people who apparently see no evil in this if the elongation is satisfactory, as it generally is, forgetting that certain forms of brittle material are quite satisfactory judged by the elongation. Owing to the readiness with which this measure of ductility can be applied it is in almost universal use, but the fact alone that bend tests are also required with steel plates should be an indication that it is not an absolute determination of the suitability of the steel. Unquestionably the use of the pyrometer might be extended in dealing with the annealing of such important material, and it is difficult to believe that the trifling extra expense would not be soon repaid by the avoidance of expensive rejections.

In most of these plates the chemical composition is not abnormal, and would not be objected to for most purposes; that is, the sulphur and phosphorus do not exceed 0.06 per cent., or if they do, it is only by a small amount. In large plates, however, where the work done on them is comparatively small, it is necessary for the metal to be exceptionally pure, and it must be remembered that both the major and minor segregations increase with large masses of steel. Phosphorus and sulphur unfortunately segregate so much that, although a certain percentage would be harmless enough if distributed evenly, it may produce failure owing to these segregations. For these reasons it is suggested that 0.05 per cent. should be the limit for phosphorus, especially if there is an appreciable quantity of arsenic present; the latter element is one whose bad qualities are not always fully realised, and it is a good plan, as adopted at least one works, to add the quantity of it and phosphorus together in estimating the suitability of the steel, in which case the total should not exceed, say, 0.06 per cent. It also appears that phosphorus has a strong tendency towards turning the pearlite into cementite, which occurs also if the plate is heated for some time at a temperature below 700 deg. Cent.

It is sometimes urged that, owing to the progress of knowledge and increased skill in manufacture, the nominal factor of safety of marine boiler shells might be reduced. It is also argued that the joints themselves do not fail, and that the shell plate itself has a fairly large factor, *e.g.*, with a nominal factor of 4.5 for the joints and a percentage strength of 85 the theoretical factor of safety of the shell plates would be nearly 5.3. So far as the steel itself is concerned, the facts given in this paper should be a sufficient answer, but it is well also to remember that the calculation of the mechanical stresses in boilers is not so simple as is often supposed.

Although not mentioned in the heading "Probable Causes of Failure," there is one which is, as it were, a master cause, and that is insufficient work on the steel due to the plates being made from too small an ingot. The exact proportions are not available in all the cases, but apart from the instances given in this paper, the author has ample experience as to the evil effect of using too small ingots. In the first place, there is the risk of including part of the major segregate, the position of which varies, as is well known, but from experience it is found that if the weight of the plate as cut much exceeds 45 per cent. of the ingot there is an increasing probability of including part of it, and with 60 per cent. the probability almost becomes a certainty. It must be understood that ingots of the usual proportions are considered, and that about 5 per cent. is cut off the bottom ends. If a larger proportion is cut off there will naturally be more danger of approaching the major segregate with the plate slab, and for this reason it is desirable to allow a fair margin with the percentage. With special methods of casting a higher proportion could doubtless be used, but this is a matter which rests with the steel maker. Even if this is done the objection still remains that insufficient work is put upon the material, and this is a point of the greatest importance. In the first place, work removes to a large extent the deleterious effects of the minor segregations of phosphorus, and, secondly, it makes the material more reliable and ductile. This latter quality is unfortunately only partially measured by the elongation of the tensile test piece, for as is well known it is possible to get steel castings giving as good results so far as strength and elongation are concerned as rolled steel, yet no one would care to stand in front of a boiler under steam if the shell plates were made of cast steel. The percentage of reduction of area is a more reliable measure of true ductility, but to obtain the necessary particulars considerably more time would be required than is usually available.

To some extent the work put into the plate may be estimated by the chemical analysis. It is recognised in steel works that the carbon content must be increased with the thickness, which means that the work done on the material is reduced, even allowing for the fact that thick plates are generally finished at a higher temperature than thin ones. The author suggests, therefore, that a limit of carbon and manganese might be required for each tensile limit in the same way that the amounts of sulphur and phosphorus are restricted. Plates Nos. A11 and B3 may be quoted as examples of the want of this restriction; in these plates the carbon was 0.35 and 0.3 per cent. for a thickness of $1\frac{5}{16}$in. and $1\frac{1}{8}$in. These quantities approach those allowed for steel castings, and indeed the structure of these plates was similar to that material. The longitudinal tensile tests of these plates gave, however, quite satisfactory results, but both plates are typical of the use of two small ingots with a high finishing temperature.

To sum up, it would appear that in order to eliminate the risk of failure the following points should be complied with:—

(1) Large ingots; the proportion of the weight of the plate as cut not to exceed about 45 per cent. of that of the ingot.

(2) Effective annealing, the pyrometer being always used and a record kept of the temperature to which each plate was subjected as well as the length of time it was in the annealing furnace.

(3) Low phosphorus, not to exceed 0.05 per cent., or with arsenic 0.06 per cent.

(4) Inspection of all parts which require dressing by an independent inspector, no plate to be accepted at the boiler works which has been dressed, and has not been stamped by the inspector on the dressed part. (This has been done by the Board of Trade for many years.)

(5) Occasional transverse tests to be taken from the centres of the ends or sides of the plates corresponding with the longitudinal axis of the ingot.

## FORTHCOMING ENGAGEMENTS.

### TO-DAY.

PHYSICAL SOCIETY OF LONDON.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. "Volatility of Thorium Active Deposit," by Messrs. T. Barratt and A. B. Wood; "The Passage of a Particles through Photographic Films," by Messrs. H. P. Walmsley and W. Makower; "On a Null Method of Testing Vibration Galvanometers," by Mr. S. Butterworth; "Experiments with an Incandescent Lamp," by Messrs. C. W. S. Crawley and S. W. J. Smith. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. "The Mortuary Chapels of the Theban Nobles," by Mr. Robert Mond. 9 p.m.

BRITISH ASSOCIATION OF MEMBERS OF THE VEREINES DEUTSCHER INGENIEURE.—At Frascati's Restaurant, Oxford-street, London, W. Herr Regierungsbaumeister Karl Bernhard, Lecturer at the Charlottenburg College, will read a paper in German on "Die Entwickelung des Eisenbaues und seine modernen, besonders ästhetischen Anforderungen" ("Recent Developments in Steel Construction, with special reference to its Æsthetic Requirements"). 8 p.m.

### SATURDAY, MAY 23RD.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Visit to the works of Richard Garrett and Sons, Limited, at Leiston.

### THURSDAY, MAY 28TH.

THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS.—At the Institution of Electrical Engineers' building, Victoria Embankment, London, W.C. 2.30 p.m.

THE CONCRETE INSTITUTE.—Denison House, Vauxhall Bridge-road, S.W. Fourth annual general meeting at 4.30 p.m. The annual dinner will take place at Connaught Rooms, Great Queen-street, W.C., the same evening.

### FRIDAY, MAY 29TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. Professor J. C. Bose, on "Plant Autographs and their Revelations." 9 p.m.

### THURSDAY, JUNE 4TH.

THE INSTITUTION OF MINING ENGINEERS.—In the Rooms of the Geological Society, Burlington House, Piccadilly, London, W. 11 a.m. The twenty-fifth anniversary of the foundation of the Institution will be celebrated at a dinner to be held at the Hotel Cecil in the evening, 7 p.m. for 7.15 p.m.

### TUESDAY, JUNE 9TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH LOCAL SECTION.—Annual summer outing. Leave Central Station, Glasgow, for Wemyss Bay at 9.30 a.m., thence per steamer *vid* Kyles of Bute to Arran, arriving Whiting Bay at 1.40 p.m., returning at 2 p.m. *vid* Garroch Head.

### THURSDAY TO SATURDAY, JUNE 11TH TO 13TH.

THE INSTITUTION OF WATER ENGINEERS.—Summer meeting at Stockport. For programme see below.

### MONDAY TO SATURDAY, JUNE 15TH TO 20TH.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.—Nineteenth annual Convention at Birmingham. For programme see page 566.

CONTRACTS.—The South Indian Railway Company, Limited, has just placed an order with the Motor Rail and Tramcar Company, Limited, of 79, Lombard-street, E.C., for the supply of three "Simplex" seventy-passenger rail coaches, each coach to be 40ft. over headstocks and propelled by a 45 horse-power motor in conjunction with a "Dixon-Abbott" gear box, affording three speeds in both directions, operated from either platform. These coaches are designed for a speed of twenty-five miles per hour.

FIRE PROTECTION AT AN AGRICULTURAL SHOW.—The fire protection arrangements at the Bath and West and Southern Agricultural Show, which is being held at Swansea on May 28th until June 2nd, have again been entrusted to Merryweather and Sons, Limited. An equipment of motor and horsed fire engines will be installed at the firm's fire station in the yard, while fire-main piping will be laid down through the grounds, with hydrants at various points. Hand fire pumps and other apparatus for "first-aid" will also be stationed at suitable points. A detachment of the Merryweather Fire Brigade will be in attendance, the firemen being on duty day and night.

THE INSTITUTION OF WATER ENGINEERS.—The nineteenth summer general meeting of the Institution of Water Engineers will be held at Stockport, on Thursday, Friday and Saturday, June 11th, 12th and 13th next, under the presidency of Mr. Thomas Molyneux. Assoc. M. Inst. C.E., Corporation waterworks engineer. The meetings will be held in the Town Hall, Stockport, and at the opening of the proceedings on Thursday the Institution will be welcomed to Stockport by the Mayor, Councillor Thomas Worthington Potts, J.P. The following papers have been promised for reading and discussion at this meeting:—(1) "The Character of Mechanically Filtered Water," by Professor Sheridan Delépine, of the University of Manchester; (2) "The Aeration and Filtration of Water for Swimming Baths," by L. Holme Lewis, M.I. Mech. E., Member; and (3) "Notes on Scraping a 15in. Water Main," by J. S. Barrowclough, Member. A lecture, entitled "The Geological Structure of the Stockport District," will be delivered by Professor George Hickling, D.Sc., of the University of Manchester. The President-elect, Mr. Thomas Molyneux, will deliver his presidential address on the Thursday morning, and will also supply a description of the Stockport waterworks, with map of the district of supply, which will be circulated amongst those present at the meeting. On the Thursday afternoon visits will be made to the Wilmslow pumping station and softening works, and to the Alderley balancing reservoir—reinforced concrete, under construction. On the Friday visits will be made to the recently completed Kinder reservoir and filtration plant and to the Lyme Park reservoirs: also to the works of Mirrlees, Bickerton and Day, Limited, Hazel Grove. On the Saturday afternoon members will be free to visit the Colliery Exhibition or the Victoria public baths. At the latter will be seen an installation for filtering the water used in the swimming baths. The annual dinner will be held at the Midland Hotel, Manchester, on the Thursday evening.

## THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

*(From our own Correspondent.)*

### Good-bye to the Tube Strip Association.

COMPETITION in the iron tube strip trade has nearly reached the stage of bidding "Good-bye" to the Staffordshire Tube Strip Association. Formed some fourteen years ago and consisting of about eighteen firms, this "combine" has lasted longer than many. For a long while the trade has been the subject of severe foreign competition, large quantities of strip coming into the Birmingham and Staffordshire district, for use by the wrought iron tube makers, from Belgium and Germany. There has also been home competition by about half a dozen firms outside the "combine." A serious view has now been taken of the position, and it is agreed that the Association must reconsider its policy. It has been suggested that the compact should be formally dissolved. Rather than do this, however, it has for the present been resolved that members shall have a free hand in the matter of prices, and that the Association minimum of £6 10s. to £6 12s. 6d. is no longer to be considered binding. Here, then, is the natural danger to the continuance of the "combine," and although formal action is understood to stand postponed, the Birmingham market seems fairly persuaded that the Association is "tottering to its fall."

### Weaker Galvanised Iron Prices.

Galvanised corrugated sheets, after remaining fairly steady for a good stretch, are distinctly weaker, and prices have got down to £10 17s. 6d. to £11 2s. 6d. for 24 w.g. material f.o.b. But for the successful operation of the makers' association, there is no doubt that prices would have suffered much more disturbance. The combine is at least happily preventing unrestrained competition amongst the makers for the export trade. The falling off in trade at date is chiefly with the Argentine and other of the South American markets. Australian conditions have also been prejudicial to trade expansion. The total shipments of galvanised sheets last month to all export markets were 63,612 tons, against 67,914 tons in April, 1913. Plain black sheets as a raw material for the galvanisers are in slow request, with easier prices at £7 10s. to £7 15s. for sheets of 20 w.g., and £7 12s. 6d. to £7 17s. 6d. and on to £8 for 24 w.g. material.

### Engineering Trades.

There is still, happily, a good deal of employment among the engineering trades and the related trades of the Birmingham district. Machine tool firms are well engaged, though demand is getting more spasmodic. There is a moderate amount of activity in the bridge building yards, but the competition for new business appears to be more strenuous. The rolling stock builders have fortunately a good deal of work on hand, though orders are irregularly distributed. The continuous great activity in the motor car and power commercial vehicle trade is a most valuable support to the Birmingham district at the present juncture. Many of the firms are extending their plants so as to be able to maintain their present output without resorting to the costly expedient of overtime.

### Raw Iron Market.

Demand in the pig iron trade remains sluggish, particularly as regards forge iron, but the continued improvement in prices on the Cleveland market, accompanied by a reduction in warrant stocks, is regarded here with satisfaction. South Staffordshire common forge iron is moving off at 48s. and upwards, while Staffordshire part-mine iron, which is taking most of the orders, commands 50s. to 51s. per ton. Best all-mine iron is quoted 85s. to 90s. for forge qualities, and 92s. 6d. for foundry. Northampton iron is selling as low as 47s. 6d. for forge, though some makers still demand 49s. per ton. Northampton foundry sorts are quoted 51s. to 51s. 6d.; Derbyshire forge is quoted 51s. per ton and on.

### The New Steel Price Conditions.

The new steel price conditions in relation to export trade continue a source of great interest. The reduction of 10s. per ton in boiler and ship plates registered by the three national associations last week is welcome to exporters, as enabling them the better to deal with the severe competition of German and Belgian makers abroad. The decision has, however, disappointed large consumers at home by giving no reduction in country prices. How long this partiality will last, however, is the one matter which is this week being most canvassed by the steel consumers. As regards raw steel, it has to be recorded that sheet bars on the Birmingham Exchange have now got down to £4 12s. 6d. and £4 15s. for Bessemer sorts of home manufacture, and £4 15s. to £4 17s. 6d. for Siemens sorts.

### Birmingham Brass Trades.

Though the Birmingham brass trades are less busy than six months ago, there is plenty of work on the books for some time ahead, and manufacturers believe that with an admitted shortage of houses all over the country at the present juncture, a busy time is not a long way off. New housing schemes of large dimensions, it is thought, must be put in hand very soon. The foreign trade at date is not equal to the home demand, there being a considerable falling away here, and German competition is still growing. The exports of brass and manufactures of brass, not being ordnance, last month totalled 1095 tons, valued at £116,453, against 1169 tons, valued at £142,657, in April, 1913, and £108,721 in April, 1912. Engineering brass-founding is the best of the departments of the foreign trade at the moment.

## NOTES FROM LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

### Pig Iron Still Idle.

THERE was a very meagre attendance on the Iron Exchange on Tuesday, and in all departments trade could only be described as of a dull and dragging character. Pig iron continued idle and featureless, although there was little change in prices. Hematite, however, fairly maintained late rates. There was little new to record in finished iron and steel. Copper and sheet lead also ruled quiet and unchanged. English tin ingots, however, showed a reduction.

### Quotations.

Pig iron: Lincolnshire, No. 3 foundry, 56s. 6d.; Staffordshire, 57s.; Derbyshire, 57s. to 57s. 6d.; Northamptonshire, 57s. 6d.; Middlesbrough, open brands, 60s. to 60s. 8d. Scotch (nominal): Gartsherrie, 68s. to 68s. 6d.; Glengarnock, 65s. 6d.; Eglinton, 64s.; Summerlee, 67s., delivered Manchester. West Coast hematite, 64s. 6d. to 65s.; East Coast ditto, 62s., both f.o.t. Delivered Heysham: Gartsherrie, 66s.; Glengarnock, 63s. 6d.; Eglinton, 62s. 6d.; Summerlee, 65s. Delivered Preston: Gartsherrie, 67s. to 67s. 6d.; Glengarnock, 64s. 6d.; Eglinton, 63s.; Summerlee, 66s. Finished iron: Bars, £7 5s.; hoops, £7 12s. 6d. to £7 15s.; sheets, £8 12s. 6d. Steel: Bars, £6 7s. 6d. to £6 12s. 6d.; Lancashire hoops, £7 7s. 6d.; Staffordshire ditto, £8 5s. to £8 7s. 6d.; sheets, £9 to £9 5s.; boiler plates, £7 5s.; plates for tank, girder, and bridge work, £6 12s. 6d. to £6 15s.; English billets, £4 15s. to £4 17s. 6d.; foreign ditto, £4 5s. to £4 7s. 6d.; cold drawn steel, £9 10s. to £9 15s. Copper

Sheets, strips, &c., £78 per ton; small lots, 10d. per lb.; rods, £77 per ton; small lots, 10d. per lb.; tough ingots, £69; best selected, £69 to £69 10s. per ton; copper tubes, 9½d.; solid-drawn brass tubes, 7½d.; brazed brass tubes, 9½d. to 9¼d.; condenser tubes, 8½d.; condenser plates, 7½d.; rolled brass, 7¼d.; brass turning rods, 6¾d.; brass wire, 7¼d.; yellow metal, 7½d. per lb. Sheet lead, £22 10s. per ton. English tin ingots, £156 per ton.

### The Lancashire Coal Trade.

There was only a small attendance on the Coal Exchange, and whilst sellers showed no great disposition to press for business, buyers were indifferent and operated to cover immediate wants only. In house coal the hot weather naturally caused buyers to hold off, and business was of a "hand-to-mouth" character. Whilst nothing definite has yet been decided upon it is probable that the renewal of contracts for house coal will be on last year's basis. There is little new to record in slack and engine fuel. Shipping and bunkering coal also continue quiet. Quotations:—Best Lancashire house coal, 17s. 8d. to 18s. 10d.; good medium, 16s. 2d. to 17s.; domestic fuel, 13s. 5d. to 14s. 5d.; screened steam coal, 11s. 6d. to 13s.; slacks, 9s. to 10s. 9d. per ton at the pit.

### High-speed Planing Machines.

I had an opportunity a few days ago of inspecting a batch of five high-speed planing machines which Messrs. Smith and Coventry have just completed for the French State Railways. The machines are built on the new Bateman principle, with which our readers are familiar. Two are specially designed for planing railway rails, and differ from the standard types in that they are more powerful and of stiffer construction. They have a capacity of 17ft. by 42in. The cross slide is made permanent with the uprights, which are carried up higher to give a greater length of belt. On the top of the uprights is an entablature to carry a 25 horse-power constant speed electric motor of the shunt-wound type, which runs at a constant speed of 630 revolutions. On the cutting stroke this machine gives 84ft. of belt travel to 1ft. of table travel, and on the return stroke the ratio is 23 to 1. There are two tool slides, each carrying a tool head for two tools. The heads have vertical adjustment and automatic longitudinal feeds in and out, and are balanced. Some tests taken in the presence of the French Government inspectors are worthy of special mention. They were made on two rails of 50 tons tensile, with two tools simultaneously. The cuts were 1¼in. deep by $\frac{5}{32}$in., at a speed of 30ft. per minute, and the average power consumed was 17 horse-power. Running light with a 16ft. stroke, cutting speed 30ft., return stroke 100ft., five cycles, the calculated time being 3 min. 28 sec., the actual time taken was 3 min. 30 sec., and the average horse-power per hour 2.35. On a 4ft. stroke, with the same number of cycles, the calculated time was 52 sec., and the actual time 55 sec., the average horse-power being 3.06. The power is transmitted from the electric motor by a 3in. belt on the cutting stroke and by a 2¾in. belt on the return stroke. The three smaller planing machines are of the standard type with a maximum cutting speed of 45ft., and 130ft. per minute return.

### Angle Indicator.

A simple device for readily showing the angles of inclined planes or surfaces has been sent me by Mr. Wilfrid Mason, 20, Moss-street, Rochdale. It is made of wood, and is small enough to fit in the pocket. The chief feature of the invention is a pendulum which takes up a position in a radial slot, according to the angle of the surface on which the straight edge of the instrument is placed. The outer edge of this slot has clearly marked on both sides angles between zero and 90 deg., so that they can be seen from either side, and in any position, whether from above or below. The pendulum is the only metallic part of the instrument and is non-corrosive. The body part is of three-ply mahogany with the grain of the centre layer running at right angles to that of the outside layers, so as to give strength to the thin parts and prevent warping.

### Engineering at the Manchester Grammar School.

As a contribution for the further development of the manual training of the students at the above school, Sir William Mather has recently presented the school with an engineering workshop outfit, which he formally handed over on Tuesday last. The equipment includes machine tools and fitting appliances, and will form a valuable addition to the technical training side of the school.

### Dry Docking the Aquitania.

On Friday last the new Cunard liner Aquitania was successfully docked in the new Gladstone Dock at Liverpool, where the firm of H. and C. Grayson are completing her equipment before her first sailing on May 30th. The huge vessel drew up close to the dock entrance at 2.40 p.m., and at 3.15 the caisson which divides the dock from the river was closed. There was a depth of 40ft. of water in the dock, and this was subsequently pumped out by the Diesel pumping plant.

BARROW-IN-FURNESS, Thursday.

### Hematites.

There is little change to note in the general condition of the hematite pig iron trade of this district. If anything, there is a rather fuller inquiry for iron on the part of general users, but there is no rush of business, and makers are working along at the old rate of production, having some good contracts in hand. There are fourteen furnaces in blast in Cumberland and eight in North Lancashire, and the whole of the iron produced is finding immediate use. Prices are unchanged at 66s. to 67s. per ton net f.o.b. for mixed numbers of Bessemer iron, and the fact that there is no tendency to lessen rates is set down as one reason for the better inquiry, consumers being of opinion that the bottom has been reached as regards rates. The consumption of iron by local steel makers is considerable. For special sorts of iron there is a steady demand, and the current price is 72s. to 74s. per ton net. There is no business being done in warrant iron, and the quotation is nominally at 61s. per ton net cash.

### Iron Ore.

There is a quietness in some parts of the district in the iron ore trade, and a few less men are employed, at any rate for the time being. This more especially applies to the Furness district. In South Cumberland there is no falling off in the activity, and a big output of high-grade ores is being maintained. The shipping of ore from Cumberland ports is still very considerable, whilst at Barrow the shipping business is quiet. Prices are unchanged, with good average sorts of native ore quoted at 13s. 6d. to 15s. 6d. per ton, and the best qualities are at 20s. 6d. per ton net at mines, a price at which they have remained for some time. Spanish ores are in steady demand at 16s. to 17s. per ton delivered to West Coast works for average qualities.

### Steel.

The steel trade is on the whole well employed, although in some of the departments there is not the briskness industrially there was some weeks ago. Rails are being turned out in good tonnages from both the Barrow and the Workington districts. The rails are for the Colonies and India to a large extent, but home users' claims are also being satisfied. The plate mill at Barrow is pretty well employed, and the hoop mill is busy, but nothing is being done in tin bars or billets. The demand for steel rails is easy, with heavy sections quoted at £5 17s. 6d. to £6 2s. 6d. per ton. For light rails there is a quiet demand, and heavy tramway sections are not much inquired after. Both these sorts are quoted at £6 7s. 6d. per ton. There is a steady demand for steel ship plates, which are quoted at £6 10s. to £6 15s. per ton, and boiler plates are a pound more. Hoops are at £8 5s. per ton, and are in steady request.

### Shipbuilding and Engineering.

There is much briskness in these two trades. In the yards and shops there is a busy state of affairs, and this will be added to when work is commenced on the new order, a second battleship for Turkey, larger and more powerful than the Reshadieh, now fast approaching her trial stages at Vickers' works.

### Fuel.

The demand for coal and coke is brisk. Good steam coal is at 15s. 6d. to 18s. per ton delivered, and East Coast coke is quoted at 19s. 6d. to 22s. per ton delivered, with Lancashire sorts at 18s. and Welsh qualities at 20s. per ton delivered.

## THE SHEFFIELD DISTRICT.

*(From our own Correspondent.)*

### The Outlook.

THE position in the iron and steel trades here continues in about the same groove, though some manufacturers hold the opinion that matters are improving. The lull, however, is decidedly pronounced in some of the important branches, and an increasing number of moulders are being suspended at various works. In the early part of the week the number was stated to be 150. At the same time, there are many instances of really active trade. The activity of the armament firms, on both home and foreign account, is benefiting very many manufacturers in the city. Railway steel is still doing very well, and when industrial progress is permitted to get under way in China there should be a good volume of such work falling to Sheffield's share. Makers of Siemens steel report that business has only been retained in many cases by reducing prices. The inquiry for basic steel seems rather better, but crucible steel is in poor demand, and small makers whose trade mark possesses no special value are not getting much business. Foreign markets are difficult, but the home trade is fairly good, though so far as Sheffield is concerned really pronounced depression is only being staved off from many firms by the heavy demands of the automobile building industry; this and requirements such as light steel cranks, &c., for airship construction, keeping quite brisk. In most other departments orders are coming in very sluggishly. For months buyers have been maintaining an extraordinarily cautious policy, and the fact that this cannot for ever be maintained encourages the belief that a revival in this district is quite possible before very long.

### Steel Alloys.

The market for alloys has been drooping for some considerable time. The drop in the output of tool steel has appreciably lessened the demand for rare metals generally, and makers have found it necessary to lower their prices. Tungsten has dropped to 2s. 3½d. per pound, or even 2s. 3d.

### Engineering.

Heavy engineering continues fairly busy, sufficient orders being booked to keep makers working regularly. There is also a good demand for small lathes. The activity which for a long time characterised the works where large gas and oil engines are made no longer obtains, but small oil engines for farm work are selling freely, and there is an increased demand for engines of the Diesel type which burn the crudest oils.

### Raw Materials.

Users of all classes of pig iron are continuing their policy of holding off the market, and the approach of midsummer is having no influence upon the situation. As a rule at this period the renewal of half-yearly contracts is under consideration, but scarcely any user can be induced even to discuss the question. Unless a change of opinion occurs very shortly a large tonnage of contracts will disappear from makers' books at the end of next month. The present year establishes a record in the smallness of business in pig iron which has been booked forward. On the other hand, the absence of business and a shrinkage in specifications has had no effect in further reducing prices. It is feared that more furnaces will have to be damped down unless consumption increases. A fairly good tonnage of hematite iron is being delivered in Sheffield, the bulk of which goes to the armament works. Forge iron is still neglected. West Coast ordinary makes of hematite are quoted at about 73s., and East Coast about 68s., delivered Sheffield. Lincolnshire foundry is 54s. 8d. to 55s. 2d., forge about 53s. 8d., and basic 2s. more. Derbyshire foundry is quoted 54s. 6d. to 55s., and forge about 50s.

### Round the Works.

From what I can gather, new business in the industrial departments is chiefly on account of railway steel, large tonnages of which are being made for India, Australia, and South America. In China, where Sheffield has done some important tramway work, preparations are being made for the construction of several thousand miles of railway, and as most of the money for this has been raised in Great Britain it is anticipated that a proportionate share of the contracts will be placed in this country, in which case Sheffield will be one of the centres to benefit. In many directions, however, orders from foreign and colonial markets are not coming in freely by any means. The Japanese Government has practically suspended buying for its War Department owing to the discovery of alleged extensive corruption among the officials, but Russia is placing business here very generously, the orders being chiefly for steel, implement parts, files, saws, shovels and spades. The news that Vickers Limited have secured the contract for another battleship for the Turkish Government caused much satisfaction in Sheffield, and if the reported provisional placing of huge contracts with a British group by the Spanish Government prove correct that, too, will be very good news for this city, inasmuch as the British group now operating in Spain consists of Vickers Limited, John Brown and Co., and Armstrongs. So far, however, I have been unable to obtain any confirmation of the report, but I believe a large quantity of war material is awaiting dispatch now from Sheffield to destinations in Spain and Italy.

### Fuel.

The steam coal market appears to be showing a very undecided tendency. It seems to be just in one of those touchy moods when any rise or fall in the demand will speedily affect values. If the demand for shipment at the Humber ports is on anything like the same scale as last season, then there is little doubt values will appreciate. The season, however, is in full swing now, and it really looks as if the tonnage dealt with will be substantially lower than was the case last year. In that event, especially as outputs have materially increased, lower prices may be expected. Very little forward business is being arranged, and, generally speaking, buyers are only making short term contracts. Apart from industrial consumption in the heavy trades, the demand by local works is appreciably less. The iron trade generally has for some time been looking for relief on the question of fuel values, and it is quite likely that if they could obtain substantial reductions business would improve to some extent. In the smaller fuels the colliery position is on the weaker side, and while there are some stocks of considerable size, no great amount of forced selling is in evidence. Possibly this is owing to the fact that when work at house coal pits is reduced to three days a week the market for small fuels will improve. Current quotations are per ton at pits as follows:—Best South Yorkshire hards, 11s. 3d. to 11s. 6d.; best Derbyshire, 10s. 6d. to 11s.; second quality, 9s. 9d. to 10s. 3d.; steam cobbles, 9s. 6d. to 10s.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Cleveland Iron Trade.

EXTREME quietness characterises the Cleveland pig iron trade just now, and, though the present outlook is somewhat depressing, the tone is by no means despondent. Business is very quiet, but it is usually so after the first rush of the spring shipments, and, although this year the quietness is no doubt accentuated owing to the general trade dulness, the position in the circumstances is not altogether unsatisfactory. A steady trade is being done, and there is plenty of iron going away, though transactions are for the most part restricted to quite small parcels. The shipments are improving again, and the month's total should be well up to the normal May average. With the bulk of the spring shipments over, the depletion of makers' stocks, which has proceeded steadily all the year, has been recently interrupted, and makers are now showing more willingness to meet the market. Values all round are easier, and doubtless sellers would make considerable concessions if they had reason to believe that such action would result in business, but they appear to be firmly convinced that at present reductions in quotations would not induce buying to any extent. Market quotations for pig iron are said to be below cost of production, and so far as can be seen there seems little likelihood of conditions being altered to any extent at all events in the near future. The quantity of Cleveland pig iron in the warrant stores here now stands at 91,377 tons, all of which but 43 tons is No. 3 quality. Since the beginning of the month the stock has been reduced by 5160 tons. No. 3 G.M.B. Cleveland pig is 51s. 6d. f.o.b.; No. 1, 54s.; No. 4 foundry, 51s. 3d.; No. 4 forge, 50s. 9d.; and mottled and white iron, each 50s. 3d.—all for either early or forward delivery.

### Hematite Pig Iron.

The past week has seen no change of moment in the hematite pig iron trade of this district. There is still only a limited amount of business being done by producers. The reason for this state of affairs is that consumers of hematite pig iron themselves, well fixed up for the time being for obtaining supplies of iron by the fact of contracts booked some time ago, and having regard to the fact that the outlook in the steel trade is far from reassuring, are not showing any inclination to place orders, and are wanting even lower rates than the prices now quoted by makers. The general market quotation for mixed numbers of East Coast hematite is 61s. 3d. for practically any delivery, but substantial contracts could be placed at 61s.

### Iron-making Materials.

The foreign ore trade, already very lifeless, is further depressed by the condition of the hematite trade. There has been a large quantity imported under current contracts this week, but the amount of new business has been negligible. In the absence of transactions the sellers' price remains nominally at 17s. 6d. for best Bilbao Rubio ore of 50 per cent. quality, ex ship Tees. There is still a scarcity of coke, and sellers show no sign of weakening. Medium furnace kinds are commanding around 17s. 3d., delivered at the works, and in some instances nothing below 17s. 6d. will be accepted.

### Manufactured Iron and Steel.

It is now quite apparent that things are not so sound as they were so far as the outlook in the manufactured iron and steel trades is concerned, though for the moment most of the works are well employed. Producers are buying raw material very cautiously, and the reports one hears as to new business are anything but encouraging. In spite of the recent reductions in certain classes of material, there is an absence of any inclination on the part of buyers to make fresh contracts. Owing to the present cost of raw material, it is impossible for northern steel makers to sell at prices quoted by continental makers without incurring a loss. The finished iron trade is being severely handicapped by competition from abroad, and several firms are now working short time. The following are the principal market quotations:—Common iron bars, £7; best bars, £7 7s.6d.; best best bars, £7 15s.; packing iron, £6 5s.; iron ship angles, £7; iron engineering angles, £7; iron ship plates, £6 15s.; iron girder plates, £7 5s.; iron ship and girder rivets, £7 5s.; steel bars, basic, £6 5s.; steel bars, Siemens, £6 15s.; steel ship plates, £6 7s. 6d. to £6 10s.; steel boiler plates, £7 10s.; steel ship angles, £6 2s. 6d. to £6 7s. 6d.; steel engineering angles, £6 17s. 6d. to £7; steel sheets, singles, £8 5s.; steel sheets, doubles, £8 10s.; steel joists, £6 12s. 6d.; steel hoops, £6 10s.; steel strip, £6 5s.—all less the usual 2½ per cent. f.o.t.; heavy steel rails, £6; steel railway sleepers, £7 5s.; light iron rails, £7—all net at works. Cast iron chairs, £4 5s.; cast iron pipes, 1¼in. to 2in., £6 7s. 6d.; 3in. to 4in., £6; 5in. to 8in., £5 15s.; 10in. to 16in.; £5 17s. 6d.; 18in. to 24in., £5 17s. 6d.; cast iron columns, plain, £7 7s. 6d.; floor plates, £3 10s. to £3 12s. 6d., f.o.r. at makers' works. The general quotation for galvanised sheets of 24-gauge is £11 5s. per ton, less the usual 4 per cent., but makers are still experiencing great difficulty in securing orders, and a reduction is anticipated in the near future.

### Shipbuilding and Engineering.

There is not much new to chronicle as regards the shipbuilding trade of this district during the past week. There is a general cessation of orders for new vessels, especially of the tramp order, owners having no confidence as to the probability of good freights being maintained any longer. The work coming to hand consists almost altogether of additions that are being made to regular lines in order to maintain present services. It is understood that the British Admiralty has acquired a vessel in course of construction by the Blyth Shipbuilding and Dry Docks Company for the purpose of converting her to carry seaplanes. The steamer, which is the largest so far constructed at Blyth, is 352ft. long, and will be ready for launching shortly. She was originally intended for an ordinary cargo steamer, and the necessary structural alterations are now being carried out. Her propelling machinery will be placed aft, so as to leave the decks clear for the uninterrupted run which is necessary to start aircraft. There is a fairly good supply of work in the different branches of the engineering trade, and in some cases steady employment is assured for a considerable time. Two Darlington firms have just received between them a big order, which will keep their works employed at high pressure night and day for many months to come. The firms in question are Messrs. Summersons and the Railway Plant Company, and between them they have secured an order from the Russian Imperial Government for 1200 sets of crossings and switches and their necessary plant. The Leeds Steel Works are to do the rolling of the rails, the checks and runners will be made at Summersons, and the remainder at the Railway Plant Works.

### Coal and Coke.

The strong demand for coal continues, but the arranging for supplies is still very difficult. Colliery positions are filled up in many cases far into June. On the other hand, tonnage is very scarce, and freights are maintained at increasing rates.

The general position is most awkward. Durham coal prices are maintained, the collieries having plenty of business on hand. Amongst the many inquiries circulating on the market is one from the Christiania Gasworks for 50,000 tons of Durham gas coals to be shipped over twelve months. The quotation for best Durham gas coal ranges from 13s. 6d. to 13s. 9d., and second qualities from 12s. 6d. to 13s. Best Blyth large steam coals are almost unobtainable for this month's delivery, and 15s. is indicated. For June shipment there is a steady demand, and sellers are freely offered 14s. 3d. All other grades of steam coals are moving off steadily, and are held for full recent values. Durham bunkers are in fair demand, and the tone is tending steadier. Best qualities are quoted at 13s. to 13s. 3d., and seconds at 11s. 9d. to 12s. 3d. Smithy coking fuel and coke are all in moderate request, finding well-sustained support at late prices. Foundry coke is 19s. to 21s.; furnace coke, 17s. 6d.; and gas coke 13s. to 13s. 9d.

## NOTES FROM SCOTLAND.

*(From our own Correspondent.)*

### Pig Iron.

MAKERS of Scotch pig iron have been making some good deliveries, but are, nevertheless, finding it more difficult to dispose of the outputs, particularly in the case of ordinary qualities. Consumers are only purchasing for immediate requirements and inquiries continue scarce. There are 72 furnaces in blast, compared with the same number in the preceding week, and 90 in the corresponding week of last year. The import of pig iron into Grangemouth from Middlesbrough and district amounted during the week to 10,313 tons.

### Quotations.

The prices of makers' iron are unchanged, and are as follows:—Monkland is quoted f.a.s. at Glasgow, No. 1, 62s.; No. 3, 60s. 6d.; Govan, No. 1, 61s.; No. 3, 60s.; Carnbroe, No. 1, 66s. 6d.; No. 3, 62s. 6d.; Clyde, No. 1, 68s.; No. 3, 63s.; Gartsherrie, Summerlee, Calder and Langloan, Nos. 1, 68s. 6d.; Nos. 3, 63s. 6d.; Glengarnock, at Ardrossan, No. 1, 71.; No. 3, 66s.; Eglinton, at Ardrossan or Troon, No. 1, 62s.; No. 3, 61s.; Dalmellington, at Ayr. No. 1, 63s.; No. 3, 61s.; Shotts, at Leith, No. 1, 68s. 6d.; No. 3, 63s. 6d.; Carron, at Grangemouth, No. 1, 69s.; No. 3, 64s. per ton.

### The Warrant Market.

Business in the Glasgow pig iron warrant market was comparatively quiet throughout the past week, and the total turnover did not exceed 7000 tons. Forward iron has been levelled to the same price as cash iron, due to the scarcity of cash warrants, a good many of which have been taken off the market. Shipments show a falling off, and it is possible that this will cause a cessation of the withdrawals from Middlesbrough stores, the continued decrease of which has been principally responsible for the firmness of the market lately. Cleveland iron closed at 51s. 6d. per ton cash, showing a gain of 3½d. per ton compared with the preceding week. Business was also done at 51s. 7½d. per ton ten days.

### Finished Iron and Steel.

There is nothing fresh to report with regard to the Scotch steel trade. Specifications for plates are still scarce, and consequently outputs are suffering. The recent reduction of 10s. per ton on the export price of ship and boiler plates has had little effect on the volume of business passing so far, and few fresh orders have been booked. The home demand for steel material is also quiet. Although the makers of black sheets continue to be steadily employed, orders are mostly of a hand-to-mouth description, and no difficulty is experienced in obtaining deliveries. Wrought iron and steel tube makers continue quiet. Malleable iron makers have little room for encouragement, and prospects, to say the least of it, are no brighter. The latest reduction in prices has had practically no effect on trade or on the quantity of foreign importations of competitive materials, the returns of which for the month of April are larger than any one month during the past five years, and consequently home producers are in a very disappointing position.

### The Coal Trade.

There has been a general decline in the Scotch coal trade during the past week, and prices on the whole show a weakening tendency. With the exception of the best qualities of ells, splints, and navigation coals, the demand is distinctly quiet and supplies are plentiful. In smalls, trebles and doubles are quieter, and even singles, which have been strong for some time past, are feeling the depression. The aggregate shipments during the past week amounted to 309,021 tons, compared with 331,649 in the preceding week and 361,600 tons in the same week of 1913. Ell coal is quoted f.o.b. at Glasgow 12s.; splint, 11s. to 14s.; navigation, 14s. 6d. to 15s.; steams, 11s. to 13s.; trebles, 11s. 6d. to 11s. 9d.; doubles, 10s. 9d.; singles, 10s. 6d. to 10s. 9d. per ton.

### Miners' Wages.

The Scottish colliery owners have claimed a further reduction of miners' wages of 1s. per day on the present rate of wages, and base their claim on the prices obtained since the last reduction. The present rate is 7s. 3d., fixed by Lord Balfour of Burleigh in a decision dated April 27th, 1914. According to the rules of the Conciliation Board, a meeting must be called within fourteen days.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### Cardiff Coal Market.

BUSINESS during the past week has been quiet in all branches and a sagging tendency has been in evidence. The dearth of tonnage supplies due to the Spanish shipping trouble and the continued holding up of boats at Genoa has been the main factor in the market, and chartering has been very slow. As was expected, prices have eased for prompt shipment. Numerous collieries have been very near the verge of stoppage on account of wagons being short, and sellers have shown readiness to cut their prices for spot shipment in order to release wagons and so enable pits to continue working. Business, however, has been very quiet and sellers are still holding back in anticipation of the market further weakening. But colliery salesmen do not share their views and regard the easiness as only temporary in view of the near approach of the Whitsuntide holidays, when outputs will be curtailed. The official holidays in the coalfield are Whit-Monday, Tuesday, and Wednesday; but, as is invariably the case, large numbers of the men will be absent for the whole week, particularly if fine weather prevails. Under these circumstances colliery salesmen are not disposed to make concessions in their prices for shipment. Best Admiralty large rule about 19s. to 19s. 6d., with other qualities in proportion, best Monmouthshires being 17s. to 17s. 6d. Small coals have been fairly steady on the basis of 10s. 9d. to 11s. for best bunkers and up to 8s. 9d. for cargo sorts. Pitwood continues scarce and a good market at 21s. 3d. to 22s. Approximate values:—Steam coal: Best Admiralty large, 19s. to 19s. 6d.; best seconds, 18s. to 18s. 6d.; seconds, 17s. to 17s. 3d.; ordinaries, 16s. 6d. to 17s.; best drys, 18s. to 18s. 3d.; ordinary drys, 16s. to 16s. 3d.; best bunker smalls, 10s. 9d. to 11s.; best ordinaries, 10s. 3d. to 10s. 6d.; cargo smalls, 7s. 6d. to 8s. 9d.; inferiors, 6s. 9d. to 7s. 6d.; washed smalls, 12s. to 12s. 6d.; best Monmouthshire black vein large, 17s. to 17s. 6d.; ordinary Western Valleys, 16s. 9d. to 17s.; best Eastern Valleys, 16s. to 16s. 3d.; seconds, Eastern Valleys, 15s. 6d. to 16s. Bituminous coal: Best households, 19s. to 20s.; good households, 17s. to 19s.; No. 3 Rhondda large, 17s. 6d. to 18s.; smalls, 12s. to 12s. 6d.; No. 2. Rhondda large, 13s. to 13s. 6d.; through, 11s. 6d. to 12s. 6d.; smalls, 9s. to 9s. 6d.; best washed nuts, 16s. to 16s. 3d.; seconds, 14s. 6d. to 15s.; best washed peas, 14s. 6d. to 15s.; seconds, 13s. 6d. to 13s. 9d. Patent fuel, 19s. to 21s. Coke: Special foundry, 28s. to 29s.; good foundry, 22s. to 25s.; furnace, 17s. to 19s. Pitwood, ex ship, 21s. 3d. to 22s.

### Newport (Mon.).

Monmouthshires have been a rather slow section during the past week, and owing to the adverse conditions as regards tonnage supplies the market has favoured buyers, especially for spot loading. Quotations of large descriptions are nominally unaltered, but there is extremely little real strength in the market, and smalls show an inclination to ease off. Current prices:—Steam coal: Best Newport black vein large, 17s. to 17s. 6d.; Western Valleys, 16s. 6d. to 17s.; Eastern Valleys, 16s. to 16s. 3d.; other sorts, 15s. to 15s. 6d.; best smalls, 8s. 3d. to 8s. 6d.; seconds, 8s. to 8s. 3d. Bituminous coal: Best house, 18s. to 19s.; seconds, 17s. to 18s. Patent fuel, 19s. 6d. to 20s. Pitwood, ex ship, 21s. to 22s.

### Swansea.

The anthracite coal market has displayed no appreciable expansion in the demand, and during the past few days operations have by no means been heavy. Large coals and machine-made qualities have shown little actual variation in prices, though for anything like early shipment the tone was on the easy side. Rubbly culm has, however, kept pretty firm, and duff steady. Business in steam coals has been restricted, though smalls have realised rather better prices than of late. Approximate prices:—Anthracite: Best malting large, 22s. to 23s. net; second malting large, 18s. to 19s. net; big vein large, 16s. to 17s., less 2½ per cent.; red vein large, 13s. 3d. to 14s. 3d., less 2½ per cent.; machine-made cobbles, 21s. 6d. to 23s. net; French nuts, 22s. to 24s. net; German nuts, 22s. to 24s. net; beans, 15s. 9d. to 17s. 3d. net; machine-made large peas, 10s. 9d. to 12s. 3d. net; rubbly culm, 6s. 3d. to 6s. 9d., less 2½ per cent.; duff, 4s. 6d. to 5s. net. Steam coal: Best large, 18s. 6d. to 20s., less 2½ per cent.; seconds, 14s. 9d. to 15s. 9d., less 2½ per cent.; bunkers, 11s. 3d. to 12s. 3d., less 2½ per cent.; smalls, 8s. 3d. to 9s., less 2½ per cent. Bituminous coal: No. 3 Rhondda large, 17s. to 18s., less 2½ per cent.; through and through, 14s. 6d. to 15s. 6d., less 2½ per cent.; smalls, 10s. 9d. to 11s. 9d., less 2½ per cent. Patent fuel, 17s. to 17s. 6d., less 2½ per cent.

### Tin-plate and Other Quotations.

I.C., 20 × 14 × 112 sheets, 12s. 9d.; I.C., 28 × 20 × 56 sheets, 13s.; I.C., 28 × 20 × 112 sheets, 25s. 6d.; I.C. ternes, 28 × 20 × 112 sheets, 22s. 3d. to 22s. 6d.; finished black plates, £9 10s. per ton; galvanised sheets, 24 g., £10 15s. to £11 per ton. Block tin, £149 15s. per ton cash, £151 10s. per ton three months. Copper, £63 5s. per ton cash, £63 17s. 6d. per ton three months. Lead: English, £19 2s. 6d. per ton; Spanish, £18 17s. 6d. per ton. Spelter, £21 7s. 6d. per ton. Silver, 26⅞d. per ounce.

### Iron and Steel Trades.

Pig iron: Standard iron, 51s. 3d. cash, 51s. 2½d. month hematite mixed numbers, 61s. cash, 60s. 11d. month; Middlesbrough, 51s. 4½d. cash, 51s. 3½d. month: Scotch, 57s. 7½d. cash, 57s. 6½d. month; Welsh hematite, 66s. 6d. to 67s. 6d.; East Coast hematite, 65s. 6d. to 66s. 6d. c.i.f.; West Coast hematite, 66s. 6d. to 67s. 6d. c.i.f. Steel bars: Siemens, £4 11s. 3d. per ton; Bessemer, £4 10s. per ton; steel rails, heavy sections, £6 10s. Iron ore: Rubio, 17s. to 17s. 6d.

## CATALOGUES.

FERRANTI LIMITED.—A copy of this company's new catalogue on electrical heating and cooking appliances has reached us.

W. S. ROCKWELL AND CO., 50, Church-street, New York.—This is a catalogue giving particulars of furnaces for industrial heating operations.

L. P. WINBY AND CO., 13 and 14, Abchurch-lane, E.C.—A copy of a catalogue dealing with rail anchors for the elimination of rail creeping has been forwarded to us.

SIEMENS BROTHERS AND CO., Limited.—Catalogue No. 537 has reached us. It illustrates, describes, and gives prices of Obach dry cells suitable for various purposes.

FROM Davey, Paxman and Co., Limited, we have received a new catalogue dealing with traction engines. It is a well-illustrated publication and contains some users' opinions.

THE MESSER ENGINEERING COMPANY, 296–300, City-road, E.C.—From this firm we have received an interesting publication dealing with oxy-acetylene welding and cutting plants.

FROM Wm. Geipel and Co., of Vulcan-street Works, St. Thomas-street, E.C., we have received a useful table giving resistances and weights of different sized aluminium conductors.

MANLOVE, ALLIOTT AND CO., Limited, Nottingham.—Two new circulars have been forwarded by this firm. One is entitled "Types of Drying Machines and Plant," and the other "Types of Filter Presses."

BRETT'S PATENT LIFTER COMPANY, Limited, Coventry.—An attractive catalogue dealing with Brett's hammers, furnaces, and presses has reached us. It is well illustrated, well arranged, and contains much information.

T. AND E. WANBACHER, 5, Appold-street, London, E.C.—Three new lists, Nos. 86, 87, and 88, have reached us. They deal respectively with high-efficiency centrifugal pumps, small centrifugal pumps, and rotary lift and force pumps.

THE WESTINGHOUSE COMPANY, of Trafford Park, Manchester, has sent us a new and well-bound catalogue dealing with electric lamps and lighting accessories. A thumb index enables specific information to be turned up with great ease.

THE HERBERT FROOD COMPANY, Limited, Chapel-en-le-Frith, 39, Upper Rathbone-place, London, W.—A publication sent to us by this firm gives particulars of tests carried out at the National Physical Laboratory on Ferodo brake and clutch lining.

THE BRITISH THOMSON-HOUSTON COMPANY, Limited, Rugby.—List No. 500 dealing with the use of electricity in coal mines has reached us. It is a well-illustrated publication, which gives brief particulars of B.T.H. equipments at work underground.

THE BRYAN DONKIN COMPANY, Limited, Chesterfield.—A new and extensive catalogue devoted to valves has been forwarded to us by this firm. It is well indexed, well illustrated, and well arranged. It deals with valves for many kinds of service.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, Limited, Ponder's End, Middlesex.—From this company we have received an extensive catalogue dealing with electric lamps, cables, wires, conduits, brackets, ship and other fittings, shades, instruments, fans, radiators, indicators, bells, pushes, telephones, signs, and carbons.

JAMES ARCHDALE AND CO., Limited, Ledsam-street, Birmingham.—We have received a copy of a new edition of this firm's sectional catalogue on high-speed radial and vertical drilling machines. We notice that all machines are now gear driven. Cones have been dispensed with.

ST. HELENS CABLE AND RUBBER COMPANY, Limited, Warrington.—"C.T. Sheathed and V.I.R. Wiring" is the title of a little book forwarded to us by this firm. It contains illustrations showing the application of this type of wiring to various classes of service and its advantages are clearly set forth.

THE COVENTRY CHAIN COMPANY, Limited, Spon End Works, Coventry.—From this firm we have received a copy of a new publication devoted to the applications of the "Coventry" noiseless chains. The principle and advantages of these chains are clearly set forth and much useful technical information is given.

THE works and products of G. and J. Weir, Limited, of Cathcart, Glasgow, are dealt with in an admirably got up publication recently forwarded to us. All the departments of the company's works are illustrated, also many kinds of pumps, condensers, evaporisers, feed-water heaters, &c., made at those works.

THE LILLESHALL COMPANY, Limited, Oakengates, Shropshire.—A new publication sent to us illustrates various machines, &c., as made in the Lilleshall Company's works, such as converters for steel foundries, shingling hammers, slag ladles, blast furnace plant, pumping engines for sewage plant, rolling mill engines, air compressors, steam engines, &c.

BELL BROS., Ravensthorpe, Yorkshire.—An extensive catalogue containing quite a lot of information about the purification of water for the domestic requirements of cities, towns, &c., and also dealing with Bell's patented mechanical water filters has recently reached us. The Bell filter is clearly and concisely described and is illustrated. Various filter installations are also dealt with.

THE DUSSEK BITUMEN COMPANY, Canal Bank, Deptford, London, S.E.—We have received a pamphlet dealing with the manufacture of joint box compound and also a booklet giving a list of some of the users. The residuum obtained from the distillation of petroleum oil has been offered as "box compound," and the pamphlet explains how one can easily be misled by the analysis of this material.

GEO. W. GOODCHILD AND MACNAB, 56, 57, and 58, Eagle-street, Southampton-row, London, W.C.—A publication has reached us which deals with a ball bearing polishing and grinding machine. We gather that this machine has been developed to overcome some of the costly deficiencies of the disc grinder. The machine is specially adapted for use in factories devoted to the manufacture of repetition parts, particularly those where a final high-class polish is desired.

THOMAS FIRTH AND SONS, Limited, Sheffield, and 8, The Sanctuary, Westminster, S.W.—This is a catalogue giving particulars of special steels for aeroplanes. Recent developments of the hydro-aeroplane have brought into prominence the vital necessity for a high-tensile steel which will withstand the corrosive action of sea water. This has led the engineers of this firm to study the matter, with the result that the firm now puts forward with confidence steel, in sheet or bar form, suitable for a wide range of purposes in hydro-aeroplane work.

THE ASBESTOS AND ENGINEERS' STORES COMPANY, 66, Bermondsey-street, Carmarthen-place, Bermondsey, London, S.E.—Asbestos goods of all descriptions, non-conducting coverings, lubricants, hoses, mechanical india-rubber goods, Balata beltings, &c., are dealt with in a new catalogue which has recently been brought to our notice by this company. Steam users should find the catalogue very useful, for it gives particulars, illustrations, and prices of a great many things that are used in connection with steam plants. Moreover, it illustrates them.

"THE Perfect Power Meter" is the title of a catalogue sent to us by the Lunken Company, Limited, of 35, Great Dover-street, S.E. The apparatus described automatically indicates and measures the power of an engine. Two different patterns are made. One is intended as a permanent fixture to the engine, giving the engineer an exact daily record of the energy expended. This record can then be compared with the useful work performed, and with the amount of steam, coal, oil, or gas consumed. The other pattern is intended as a testing indicator. Either apparatus can equally be used for measuring the power absorbed by air compressors, pumps, &c.

BOVING AND CO., Limited, Union-court, Old Broad-street, London, E.C.—This is a new catalogue dealing with standard low lift "Victoria" turbo pumps. It contains a list of standard low lift pumps and is intended to give information on the selection of pumps for the various conditions of head, quantity, and speed of driving agent. Dimension sketches will enable readers to determine at once the space required for accommodating the size of pump selected. In addition to the standard low lift pumps referred to in this list, the firm builds standard ranges of high-pressure pumps, as well as specially designed pumps for low and high lifts and all quantities.

ROYAL METEOROLOGICAL SOCIETY.—The first of the afternoon meetings of this Society for the present session was held on Wednesday, the 20th inst., at 70, Victoria-street, Westminster, Mr. C. J. P. Cave, president, in the chair. Mr. E. Gold read a paper on "The Reduction of Barometer Readings in Absolute Units, and a new Form of Barometer Card." The Meteorological-office having now employed the C.G.S. units in its publications, this has necessitated the preparation of new tables for the reduction of the barometer readings and for the adjustment of the effect of difference between the standards of temperature 62 deg. Fah. and 273 deg. A. Mr. A. Hampton Brown also read a paper on "A Cuban Rain Record and its Application," in which he dealt with the rainfall records of the Belen College Observatory, Havana, for the period 1859 to 1912, and gave particulars of the monthly, yearly and seasonal rainfall. The average yearly rainfall for the fifty years 1861–1910 is just under 50in., but during the past fifteen years there has been a marked tendency to diminished amounts. March is the driest month with 1.91in., and October the wettest with 6.92in., followed closely by June with 6.71in. The most phenomenal month was April, 1869, when 22.57in. was recorded, falling on six days. On the other hand, April, 1896, was entirely rainless. The rainfall year can be divided into two seasons: a wet from May to October, and a dry from November to April. During the former, 35.36in., or 71 per cent. of the rain falls, the remaining 14.60in., or 29 per cent., being recorded in the dry months. The author has endeavoured to trace the connection between the wet season at Havana during May to October and the precipitation in England, South-west, and South Wales during the three months, January to March following, and he has found that from 1878 onwards when the first reports for this country are available, an excess rainfall in Havana during May to October was generally followed by a deficient rainfall in England, South-west, at the beginning of the next year, and *vice versa*. For the eight years 1888–1895 when the rainfall at Havana was continuously in excess, in England, South-west, the figures with one exception were the reverse. During the next five years, 1896–1900, there was a deficiency at the Cuban station, and, excepting 1897, an excess in this country. There were many years where the application failed, but the general continuance of the see-saw movement was so persistent that it could hardly be regarded as merely coincidental.

## NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

*(From our own Correspondent.)*

### Rheinland-Westphalia.

IT is difficult to give an exact account of the present condition of the iron and steel market in this district, because varying reports have been coming in, some stating demand and employment in the different branches to be healthy and improving, while others give a most unsatisfactory description of the state of affairs. One of the leading Rhenish-Westphalian firms is known to have offered bars at M.91, M.92 and M.93 p.t. free at works, while plates appear to be even more depressed, having been sold at M.94 to M.95 p.t. for export, and at M.98 to M.100 p.t. for home consumption. Medium sorts of plates are quoted M.104 to M.106 p.t., and sheets realise M.115 to M.117 p.t., according to quality. Tank plates have been offered at M.100 p.t. by the Gute Hoffnungshütte, the Kraft Ironworks quoting M.106.50 p.t. Hoops and sectional iron are also in a weak condition. One works near Trier has been offering hoops at M.105 p.t. free Trier, granting a rebate of 25 per cent. for 12 mm. sorts, and 50 per cent. for qualities of over 12 mm. Thyssen offers at M.114 p.t., and another Westphalian firm takes M.111 p.t. Drawn wire has shown symptoms of weakness, and the current quotation of M.117 p.t. for export is expected to go down to M.100 p.t. before long. The shipbuilding and engineering industries are reported to be well occupied; quotations, however, are complained of as being unremunerative, because competition is so keen. In the pipe industry a revival has been felt lately, and rates have stiffened a little.

### Sales of the Steel Convention.

In April this year the deliveries of the Steel Convention were 512,445 t., as compared with 560,527 t. in March this year and 566,289 t. in April, 1913. Of the above-named quantity, 133,841 t. were semi-finished steel, compared with 153,170 t. in March, and 138,710 t. in April, 1913; railway material, 199,139 t., compared with 206,324 t., and 234,252 t.; sectional iron, 179,465 t., compared with 234,252 t. and 193,327 t.

### The German Coal Market.

A steady demand and firm quotations are reported from the different coal-producing districts.

### The Iron Market in Austria-Hungary.

In all branches the tendency remains quiet as before; no forward orders are being placed for the present, and the hand-to-mouth business being done is unremunerative.

### Iron and Steel in Belgium.

Only a small amount of work is being turned out in most departments. New orders continue scarce, owing to the fact that both buyers and sellers are lacking in confidence, and are not at all inclined to trade beyond immediate wants. Exports for the past quarter show a decrease in girders and rails. Quite recently, however, girders have shown a little more life.

### Quiet Trade in France.

Makers of iron and steel find considerable difficulty in disposing of the increased production, and the larger establishments are trying hard to find a market for their output abroad. The pipe makers have been already fairly successful in this respect; last year's exports of iron pipes being 72 per cent. of the total output, as compared with only 54 per cent. in 1908. In other articles of iron, exports during the last two years have been as follows:—

| | 1913. Tons. | 1912. Tons. |
|---|---|---|
| Pig iron .. .. .. .. .. | 99,730 | 216,957 |
| Semi-finished steel .. .. .. | 320,650 | 169,882 |
| Rails .. .. .. .. .. .. | 75,689 | 47,351 |
| Plates. .. .. .. .. .. | 11,845 | 11,468 |
| Castings .. .. .. .. .. | 25,337 | 25,617 |

Regarding the present trade in iron and steel, little of importance has occurred during this and the past week. The Office for Sale of Basic Iron raised prices 10f. p.t. on April 1st. More life in building material is reported from the East Department, and foreign contracts in railway material have increased. A marked reduction in the output of pig iron has taken place in the above-named district. During the last quarter of the past year, the production was 9906 t. per day, while at present it amounts to only 9535 t. The slightly rising tendency that was recently noticed in the Nord, has given place to a marked dulness in trade. Merchant iron cannot realise more than 140f. to 145f. p.t.

## AMERICAN NOTES.

*(From our own Correspondent.)*

NEW YORK, May 6th.

Two or three factors are co-operating for more or less improvement in the steel business, among which may be mentioned the exhaustion of supplies in consumers hands, the extremely low quotations reached, and the urgent necessities of most large consumers, such as railroads. But taking the most hopeful view possible, the entire industry is in a quagmire, with over one-third productive capacity idle, and several more furnaces about to blow out. One or two large pipe iron plants will shut down. Of course, the week's business shows quite a number of fair orders and an increase in inquiries. Railroads are in the market for upwards of 20,000 tons of bridge material, and inquiries for cars within a week foot up an encouraging total of 25,000. A surprising cut of 60 per cent. has been made in Lake Superior iron ore, bringing the price to 2.80 dols. a ton at shipping dock. The Union Pacific will contract for 107 coaches at a cost close to 1,000,000 dols. The Baldwin's have taken an order for forty locomotives from the Norfolk and Western, and the Delaware and Hudson twenty-five from the American Locomotive Works. The Southern has added 1000 cars to its recent order of 4000. The Chesapeake and Ohio will order 10,000 tons bridge steel for a bridge at Portsmouth, Ohio. The Southern Power Company at Charlotte, N.C., take 1500 tons steel for transmission towers, and 1800 tons go to the Dominion Steel Company for a power-house at Abilibi Falls, Ontario. Much new work is now in sight, but with the absence of normal railroad demand the situation is far from satisfactory. A large subway contract in this city will take between 40,000 and 50,000 tons material, bids to be taken in two weeks. During April 4300 tons of steel were delivered at this port. Copper is dull. Electrolytic 14¼. Exports for month, 31,585 tons.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE Electric Supply Committee of the Corporation of the City of Birmingham has appointed Mr. E. A. Mills, of the North Metropolitan Electric Power Supply Company, to the post of assistant constructional engineer to the Electric Supply Department.

MESSRS. MCKIE AND BAXTER, engineers and boilermakers, Govan, Glasgow, have purchased the goodwill, drawings, patterns, and templates of the late firm of Muir and Houston, Limited, Harbour Engine Works, Kinning Park, Glasgow, and all correspondence regarding the business of the latter firm should be addressed to McKie and Baxter.

# BRITISH PATENT SPECIFICATIONS.

*When an invention is communicated from abroad the name and address of the Communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 8d. each.*

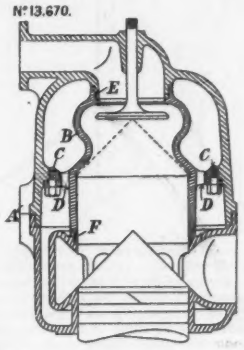
*The date first given is the date of application: the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete Specification.*

*Any person may, on any of the grounds mentioned in the Act, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of any Patent.*

## INTERNAL COMBUSTION ENGINES.

13,670. June 13th, 1913.—CYLINDER, F. Peel, jun., 128, Laygate-lane, South Shields, Durham.

This is a cylinder for a two-stroke cycle engine. The jacket is in two parts, being bolted together at the lugs A. The com-

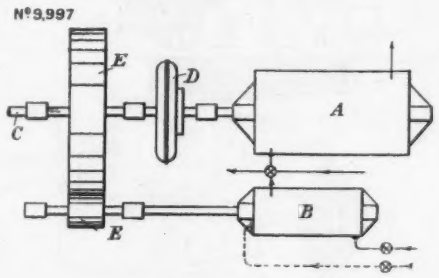



bustion chamber B is of sinuous outline to allow it to expand freely, and is studded at C to the removable part of the jacket. D are holes in the flange for the passage of circulating water. The combustion chamber is step-jointed into the jacket at E and into the cylinder at F.—*April 29th*, 1914.

## TURBINE MACHINERY.

9997. April 29th, 1913.—IMPROVEMENTS IN TURBINE INSTALLATIONS, Dr. H. Föttinger, 13, Baedeckerweg, Zoppot, near Danzig, Germany.

This specification explains that the Föttinger hydraulic gear is best suited for speed reduction ratios of 10 or 12 to 1, its efficiency decreasing for greater ratios. It is also explained that mechanical gears are not suited for the transmission of great loads per pinion. The object of the invention is the combination of the two forms of reduction devices in such a way as to obtain the best possible conditions for efficiency at all speeds. A and B are turbines, of which A drives the propeller shaft C through a Föttinger transmitter D, while B drives the shaft

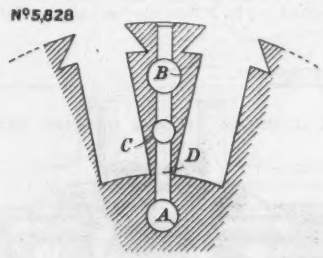



through mechanical gearing E E. The shaft C may be driven in either of two ways. In one, B is a high-pressure and A a low-pressure exhaust steam turbine. Normally, the shaft C is driven by the turbine B through the gearing E and by the turbine A through the transformer D. For going astern the transformer is reversed and the gearing rendered inoperative. Alternatively, B is a cruising turbine and A the main turbine. For full speed the gearing E is rendered inoperative. For cruising purposes the main turbine is disconnected by suitable clutches, and for reverse speed the transformer D is reversed and the gearing E disconnected. Two modifications are also described. —*April 29th*, 1914.

## DYNAMOS AND MOTORS.

5828. March 7th, 1914.—IMPROVEMENTS IN OR RELATING TO ROTORS FOR DYNAMO-ELECTRIC MACHINERY, AND TO COOLING ARRANGEMENTS FOR THE SAME, Siemens-Schuckertwerke, G.m.b.H., of 3, Askanischer Platz, Berlin, S.W., 11, Germany.

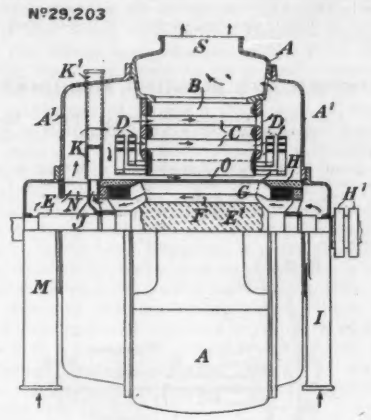
A, B and C are the axially running passages or ducts, whilst D




is a radial duct in the cross-section of the tooth. The air is introduced from one end or side or from both ends or sides of the rotor through the axial ducts, and is discharged through the radial holes, of which there may be any desired number distributed at intervals along the rotor. The size of the holes is suitably adapted to the iron cross section of the teeth, and the quantity of air which is to pass through the holes. The holes or ducts D may be so arranged that an approximately uniform discharge of air takes place all round the revolving solid rotor. In fact, the surface of the rotor may be rendered completely sieve-like by the holes, if desired. Another arrangement is also described.—*April 29th*, 1914.

29,203. December 18th, 1913.—IMPROVEMENTS IN OR RELATING TO THE VENTILATION OF DYNAMO-ELECTRIC MACHINERY, Siemens Brothers Dynamo Works, Limited, of Caxton House, Tothill-street, Westminster, S.W., and Emil Otto Kieffer, of Hough House, Lichfield-road, Stafford.

A denotes the stator housing, $A^1$, $A^1$ the end shields, B the stator core, C axial ventilating ducts in the core, and D the overhang of the stator winding. The rotor $E^1$ and shaft E are solid and in one piece, ventilating ducts F being situated at the bottom of the winding slots, which contain the rotor windings G.

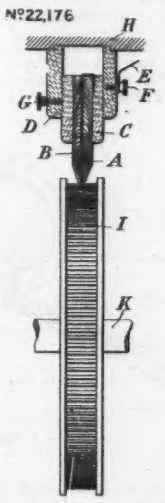



Winding caps H are provided, and current is introduced into the rotor through slip rings $H^1$. Through the inlet I air is drawn into the rotor by the fan J and passing through the ducts F is discharged into an annular channel K from which the air passes out into the atmosphere through outlet $K^1$. The stator ventilating air enters at M, being drawn in by fan N, and flowing over the channel K, passes into the stator ducts C and air gap O. The stator overhang, the stator core, and the surface of the rotor, particularly at the rotor air discharge end, are cooled by this air in its passage. Passing out of the stator at the other end, access to the outside atmosphere is through the stator chimney S, as indicated by the arrows. Another arrangement is also described.—*April 29th*, 1914.

## TELEGRAPHS AND TELEPHONES.

22,176. October 2nd, 1913.—IMPROVEMENTS IN OR PERTAINING TO BRUSH OR LIKE SLIDING CONTACTS FOR HIGH-FREQUENCY ELECTRICAL APPARATUS, Aage su Sörensen, of 12, Marienstrasse, Berlin-Lichterfelde, Germany.

The accompanying drawing illustrates an appropriate construction embodying the principle of the present invention, adapted for the detection by means of a musical note of wireless telegraphic signals. The sliding contact A, consisting of a wire, is enclosed in an envelope of insulating material B, preferably consisting of mahogany or other soft wood. The wooden pencil B is clamped in a metal holder C of conducting material which slides freely in a metallic fitting D, the entire arrangement being carried by a support H. The energy is transmitted through the



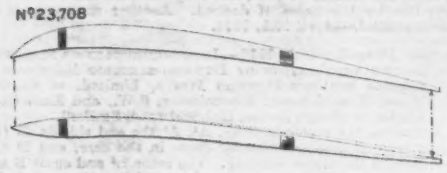

wire E and screw F and the conducting material C D to the contact A, which runs over a toothed disc I mounted on a rotary shaft K. The pressure exerted by the contact A on the disc I can be adjusted by gravity, being dependent, in the example illustrated, on the weights of the parts A B C. The contact pressure between A and I can, if desired, be determined by pressing the contact against the disc I and fixing it by means of the binding screw G, with the result that the pressure remains constant until diminished by wear of the contact A. This arrangement possesses special advantages in connection with reception by means of musical notes in wireless telegraphy and telephony, since it obviates defects arising from the exceedingly small contact surface such as irregular contact and correspondingly increased resistance to the passage of current.—*April 29th*, 1914.

## AERONAUTICS.

23,708. October 20th, 1913.—IMPROVEMENTS IN AEROPLANES, H. L., A. E., and H. O. Short, 56, Prince of Wales'-mansions, Queen's-road, Battersea Park, London.

This invention relates to the wings of biplanes. It consists simply of making the under surface of the upper wing and the upper surface of the lower wing of such a form that the space

between them is everywhere constant. By so doing, the velocity of the air between the wings is constant from point to point. It is stated that from experiments it has been found that the "drag" on a multiplane flying machine is mainly due to the

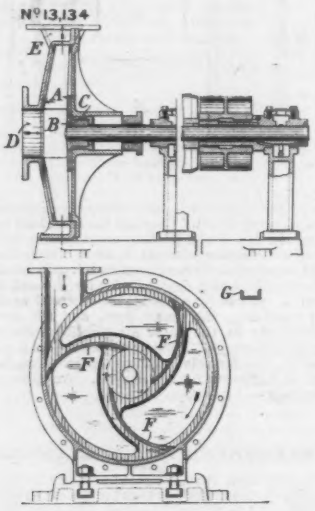



variation in the distance between the wings resulting from the dissimilarity of the opposed outlines. To allow for the reduction of velocity caused by skin friction, the rear edge of the lower wing may be slightly elevated, as shown in dotted lines.—*April 29th*, 1914.

## PUMPING AND BLOWING MACHINERY.

13,134. June 6th, 1913.—CENTRIFUGAL PUMP, Bertrams, Limited, St. Katherine's Works, Sciennes, Edinburgh, and another.

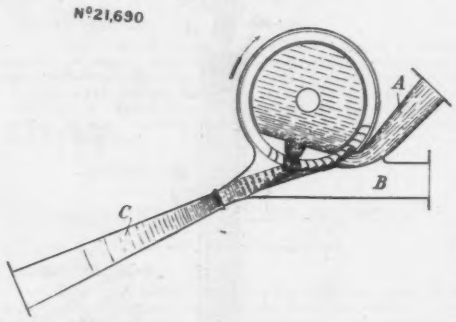
This pump is particularly intended for dealing with thick pulp in paper mills. The impeller A is formed with a central boss B, which fits inside a neck ring C carried by the pump casing. A central inlet opening is provided at D, and a dis-




charge outlet at E. The impeller blades F are curved, and their inner ends terminate at a distance from the centre of the impeller equal to the radius of the inlet D. The blades are channel sectioned, as at G, their edges being bevelled so as to sweep off any pulp which may collect on the inside of the casing. It is claimed that the impeller and its shaft may be withdrawn from the casing without disturbing the inlet and discharge pipes. —*April 29th*, 1914.

21,690. September 25th, 1913.—ROTARY AIR PUMP FOR SURFACE CONDENSERS, Société Anonyme pour l'Exploitation des Procédés Westinghouse-Leblanc, 7, Rue de Berlin, Paris.

This is a Leblanc pump intended to be capable of extracting from a surface condenser not only the air and the non-condensible gases, but also the water of condensation. In other words, is a wet vacuum pump. It consists of an ordinary Leblanc

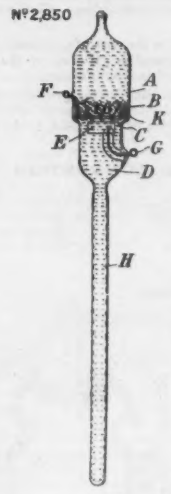



dry vacuum pump, to which is added a suction conduit A to which the water withdrawn from the condenser is supplied. This water, together with the water from the air pump, and the air withdrawn from the condenser through the pipe B are simultaneously forced into the diffuser C. It is stated that experiment shows the pneumatic power of the air pump to be practically unaffected by the addition of the water conduit.—*April 29th*, 1914.

## TESTING AND MEASURING INSTRUMENTS.

2850. February 3rd, 1914.—IMPROVEMENTS IN AND RELATING TO ELECTROLYTIC METERS, *The General Electric Company, of Schenectady, County of Schenectady, State of New York, United States of America.*

The object of this invention is to provide a simple and compact meter of this type which is cheap to manufacture and efficient in operation. A represents a circular anode chamber containing a body of mercury B forming the anode. This anode rests on a thin diaphragm C of silk or other suitable material consisting of a disc of this material stretched over a ring which is only a very little smaller in diameter than the internal diameter of the chamber. The diaphragm separates the anode chamber A from the cathode chamber D and prevents the mercury from passing downwards into the cathode or depositing chamber. The diameter of the cathode chamber is less than that of the anode chamber, a ledge being formed at the point of junction on which the diaphragm rests. The weight of the mercury keeps the disc in its place and the surface tension of the mercury prevents it from escaping round the edges or from causing the disc to float. The cathode may be a sheet or plate E of platinum or other suitable material, and it may be supported in the cathode chamber in any desired manner. Both the anode and the cathode chambers are filled with any well-known or suitable electrolyte, and the meter is connected in circuit by means of the terminals

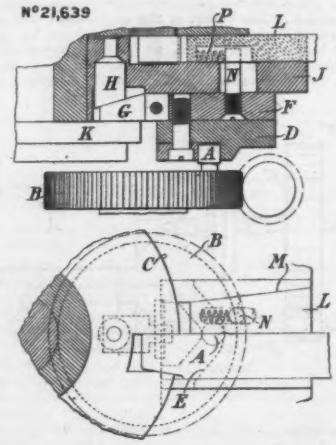



F and G. The mercury deposited on the cathode E by the passage of current drops off and collects in the graduated tube or depositing chamber H, the amount of mercury in this tube being proportional to the current which has passed through the circuit. To prevent the disc being displaced when the meter is reversed to allow the mercury deposited in the recording tube to pass back to the anode chamber, indentations K may be provided in the walls of the anode chamber which project inwards over the edges of the disc and prevent it from being displaced to any great extent.—*April 29th*, 1914.

## MACHINE TOOLS AND SHOP APPLIANCES.

21,639. September 25th, 1913.—TURRET LATHE, A. Herbert, Southfield, Kenilworth, Warwickshire, and P. V. Vernon, Penvorn, Manor-road, Coventry.

This specification describes improved means for clamping the turret and the index bolt of turret lathes. The turret, not shown, is rotated by a crank pin A carried on a disc B. C is a plate arranged under the turret. A slide D is provided with a cam groove E in which the pin A engages. As the disc B rotates

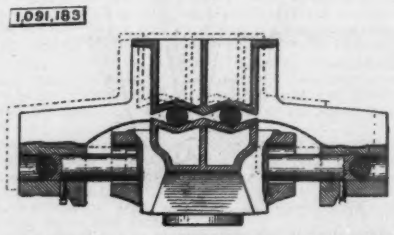



an in-and-out movement is imparted to the slide D. Attached to the slide is a plate F carrying a wedge G. When the slide is forced forward this wedge is inserted between an abutment stud H fixed to the turret slide J and a rotating plate K carried on the base of the turret. The turret is thus forced downwards and clamped in position. A wedge L lies alongside the index bolt in a suitable slot M. A peg N fixed to the slide D F engages in a slot in this wedge. As the slide D F moves forward the peg N transmits pressure through a spring P to the wedge L, and thus clamps the index bolt in position.—*April 29th*, 1914.

## SELECTED AMERICAN PATENTS.

*(From the United States Patent-office Official Gazette.)*

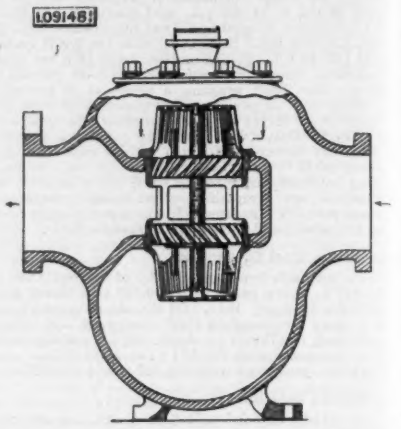
1,091,183. MEANS FOR CUSHIONING THE BODIES OF RAILWAY CARS, *W. P. Bettendorf, Bettendorf, Iowa; J. W. Bettendorf, administrator of W. P. Bettendorf, deceased.—Filed May 16th*, 1910.




The underframe comprises suitable end-sills, body bolsters, and a centre-sill, the ends of which are connected to the body bolsters. A longitudinally arranged cushioning device is carried directly by these bolsters. The car body is adapted to have a slight longitudinal movement independent of the underframe, and there are means connected to and projecting from the car body adjacent the bolsters that are adapted to engage and compress the cushioning device. There are thirty-five claims.

1,091,481. WATER METER, *J. M. Burton, New York, N.Y., assignor to Neptune Meter Company, New York, N.Y., a Corporation of New Jersey.—Filed May 10th*, 1913.

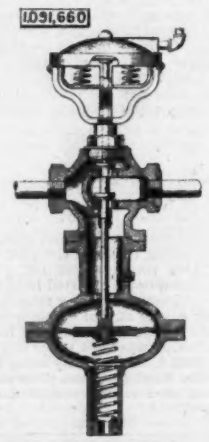
The meter casing has an inlet and an outlet and an apertured inner wall. A turbine wheel is mounted in this wall and is actuated by the flow of liquid through it. A stop plate is mounted




with the wheel, and a slotted cage is secured to the inner wall and encloses the wheel. A scraper is removably secured to the inner wall of the cage with its lower edge in juxtaposition to the edges of the blades of the turbine wheel. The body of the scraper is disposed substantially tangential to the stop plate. There are three claims.

1,091,660. PRESSURE AND TEMPERATURE CONTROL VALVE, *J. C. Hornung, Chicago, Ill.—Filed July 27th*, 1912.

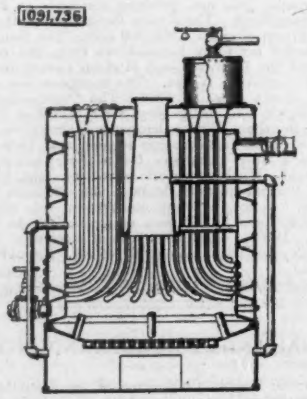
The apparatus has a valve for controlling the supply of heating fluid, this valve being normally responsive to variations in the pressure of the fluid on the egress side of the valve. A plunger




is arranged in line with the valve, and is independent of it. A spring normally holds the plunger out of operation, and a thermo-statically controlled diaphragm bears on the plunger, whereby at a predetermined temperature the plunger is forced upon the valve to hold the latter in the closed position. There are two claims.

1,091,736. VERTICAL WATER-TUBE BOILER, *F. J. Doyle, Chicago, Ill.—Filed May 10th*, 1910.

The boiler has a main fire chamber, with a fuel magazine extending vertically into it. The magazine is open only at its lower end and terminates short of the grate level. Air conduits lead from below the grate level into the fuel on the grate. Separate air conduits lead from below grate level to the combustion chamber near to the lower end of the fuel magazine,




and separate air conduits lead from below the grate level to the fuel magazine above the fuel in it. The distilled gases from the fuel in the magazine mix with the air delivered to the magazine, the fuel magazine being devoid of any outlets except at its lower end, whereby the mixture of air and distilled gases must pass downwardly through the magazine and into and through the hot fire adjacent the lower end of the magazine. There is only one claim.

## THE RIVER TRAINING WALL AT RANGOON.

ON numerous occasions in the past, notably in our issues of January 17th, 1908, July 16th, 1909 and June 2nd and November 24th, 1911, we have alluded to the extensive port improvement works which have been in progress at Rangoon during the last five or six years. Our readers will remember that among these works was the construction of a huge training wall designed to check erosion of the banks of the Rangoon River, which had been going on at an alarming rate for a number of years. This great undertaking was brought to a successful completion in the early part of this year, and was formally declared to be in service on February 17th last by the Lieut.-Governor of the Province of Burma, Sir Harvey Adamson, K.C.S.I.

By the courtesy of Mr. Geo. C. Buchanan, C.I.E., M. Inst. C.E., we are now able to reproduce herewith and on page 594 a series of photographs of this interesting work, which is undoubtedly the largest and most important river training scheme of its kind in the world, and also to place before our readers some additional particulars concerning it. In order to make this article as complete in itself as possible, we propose, first of all, and before going on to discuss the completed work, to recapitulate the information which we have given in former issues. A glance at Fig. 1, which is a reproduction of a map of a portion of the Rangoon River just above the town itself, will show the reason why this heavy piece of engineering had become necessary. The Rangoon River is formed by the junction of two other rivers, the Hlaing and the Panhlaing, the confluence of which is some five miles above the town. The mean ebb discharge of the river above the town throughout all tides during the year is about 300,000 cubic feet per second, or at the rate of 162,000 million gallons in twenty-four hours. Just off Kemmendine the river is rather over 2000ft. wide. At Mower's Point, opposite Rangoon, it is somewhat narrower than this, being about 1800ft. Between these two points there is a considerable widening out, and as long ago as 1824 there was a width at the widest point of some 4000ft. The line of bank in that year is shown by dotted lines Of recent years the south bank has become extensively eroded, and the actual line of bank in the year 1913 is shown in full lines. Meanwhile the north bank was silting up, and shoals were appearing far out in the river, the deep channel of which was going further and further south each year. The effect of this was that on the ebb tide the downcoming water on meeting Mower's Point, which is composed of clay of a fairly stiff and resisting character and is protected by revetment work, was deflected across to the north bank of the river, where it was doing considerable damage in undermining the jetties and wharves of the Port Trust. Moreover, there appeared to be a really imminent danger of the river cutting a new channel for itself to the southward of Mower's Point and of leaving Rangoon high and dry. This was a contingency which, having regard to the quickly expanding business of this important trading centre, had to be prevented at any cost.

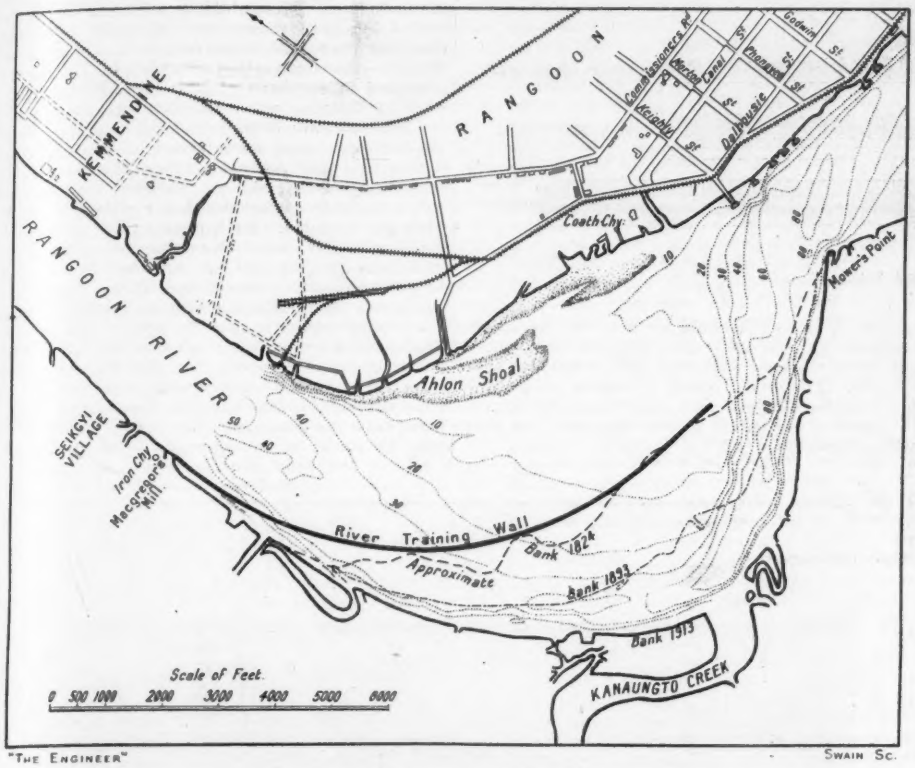



Fig 1—RANGOON RIVER ABOVE THE TOWN

The construction of any sort of training works constituted a problem of considerable magnitude and difficulty.

It will not be necessary for us to detail the various proposals which were brought forward in the past for dealing with this matter. It will suffice to say that from 1879, when the Port Authority was constituted, the matter was discussed at intervals, and the importance of doing something to stay the erosion and other damage was recognised more and more each year. It was not, however, till 1901, when Mr. Geo. C. Buchanan was appointed chief engineer, that anyone came forward with a really reasoned scheme. Mr. Buchanan quickly realised the gravity of the situation, and applied himself assiduously to solving the problem. He issued a preliminary report on the subject in 1903, and in December, 1905, a full scheme was prepared. This proposed the construction of a curved training wall some 10,000ft. long, formed by the sinking of brushwood mattresses and the building up on the floor thus formed of a rubble wall taken up to about 5ft. above low water of spring tides. The scheme received the approval of the Port Commissioners, and was submitted to the Indian Government, which handed it on to a Committee. This Committee reported in 1906 in favour of the

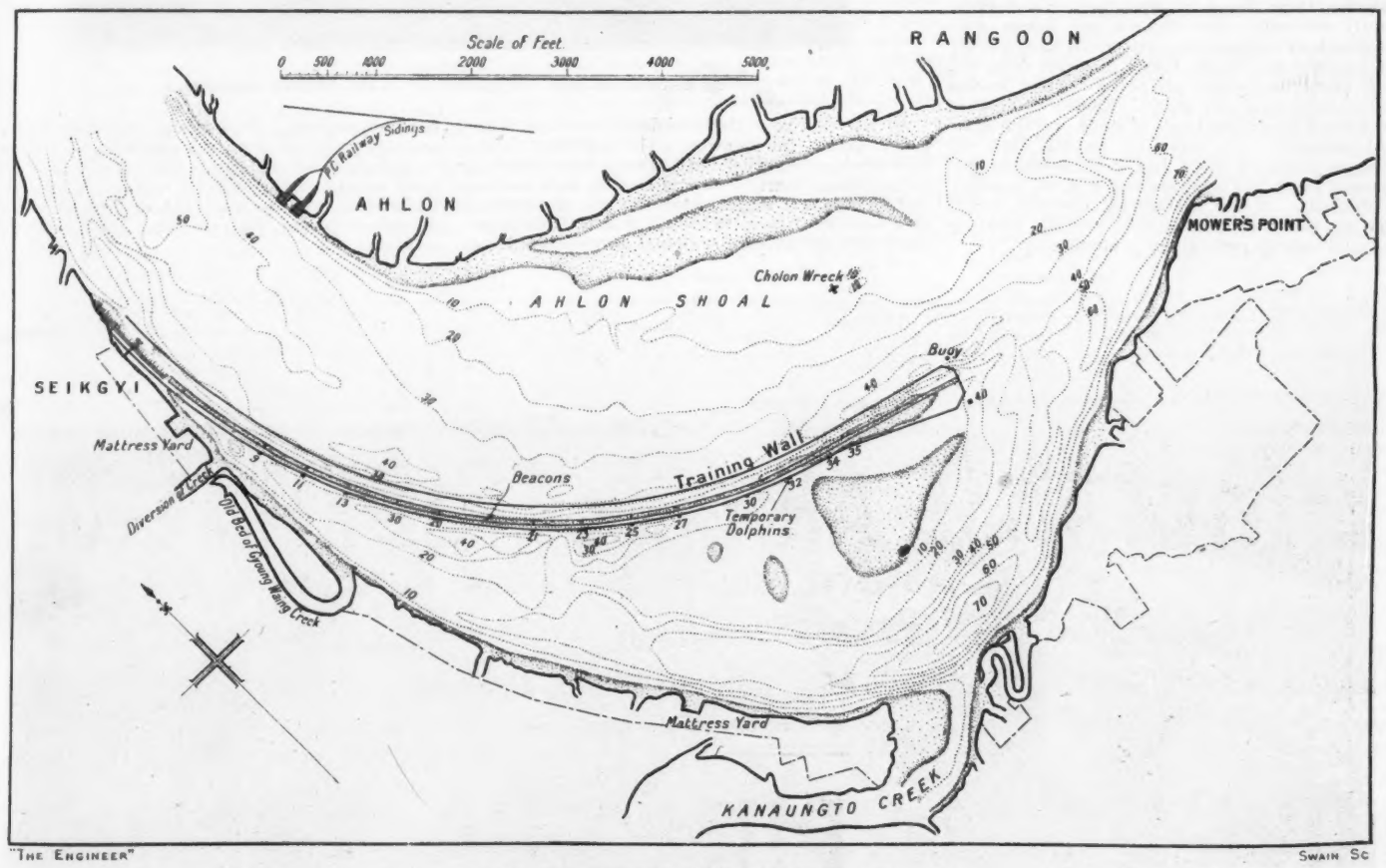



Fig. 2—THE TRAINING WALL IN DECEMBER, 1913

training wall, but there was a difference of opinion as to the method in which it should be constructed. Instead of mattresses the Committee recommended that there should be a stone or laterite floor. The dispute on this point continued for over four years, but in the end Mr. Buchanan, who all along had contended that if an attempt were made to employ a stone flooring alone, the stone would sink into the silt, gained his own way. It should be said that Sir Harvey Adamson contributed by his efforts and advice in bringing about the termination of the controversy, and that all along he did everything in his power to promote the success of the undertaking. A tribute should certainly be paid to Mr. Buchanan for adhering to his convictions in face of the weighty opposition with which he was faced, and having regard to the importance of the operations and the very large sum of money involved.

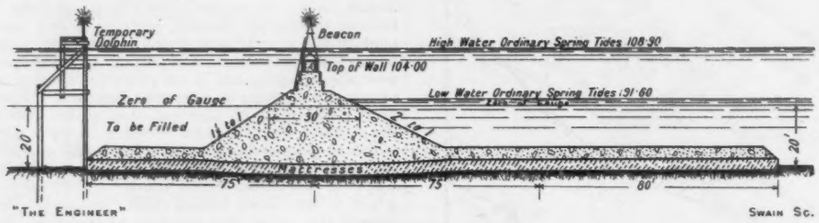



Fig. 3—SECTION OF WALL

The training wall starts from just above the village of Seikgyi where it is at a tangent to high water mark. It then is taken southward and eastward in a curve of 6000ft. radius for a distance of 8500ft., after which it is straight for the remainder of its length. It is shown in the condition in which it was in December, 1913, in Fig. 2. The continuation of its straight part would cut off a portion of Mower's Point, and we understand that it is proposed eventually to remove so much of the point as would leave a straight channel of uniform width immediately opposite the town of Rangoon.

It was decided that the work should be carried out departmentally, and not by contract, and some small idea of the magnitude of the operations may be gathered from the fact that for the construction of the mattresses more than five million bundles of brushwood and 50,000 bundles of stakes were required and that some 1,500,000 tons of granite had to be quarried, conveyed to the site and deposited.

The mattresses form a carpet or flexible floor extending the whole length of the wall. Mr. Buchanan contended from the very first—and, we believe, perfectly correctly—that without this carpet each individual load of stone deposited would have quickly sunk into the silt, which varies in depth from 6ft. to 10ft. along the whole length of the wall and overlies a bed of hard sand and gravel. Eddies would then have formed around the heaps of stone, and the latter would probably have continued sinking until the maximum depth of scour had been reached, thus increasing vastly the total amount of stone required. The flexibility of the mattresses, however, would permit of any erosion being automatically filled up and would entirely prevent any undermining.

The width of carpet provided by the mattresses is as great as 230ft., this width being required so that an apron of sufficient dimensions to protect the main wall, when built up on it, from scour should be provided. Each mattress was 125ft. long, two-thirds of the number being 75ft. and one-third 80ft. broad, and all 3ft. thick. Some 20,000 to 22,000 bundles of brushwood entered into the composition of each mattress. The mattresses were put together on specially constructed slipways, and they had to be made when these slipways were uncovered at low water. The average time required to make one mattress was seven working hours, though if occasion required it, the work could be done in five hours. This seems an incredibly short space of time, but it must be remembered that from 250 to 300 men were employed. The object aimed at was to combine in the mattresses strength with great flexibility, and in this direction the efforts of the engineers met with marked success.

As the tide rose the completed mattress floated and could be towed away to be deposited, and it may be remarked in passing that every effort was made so to arrange matters that as soon as each mattress was completed it might be towed to the site and sunk with its load of stone to keep it down. This necessitated not only the quick construction of the mattresses, but also special arrangements by which the stone might also be brought to the site so as to arrive there exactly when it was required. The operation of towing was by no means easy, though it was improved by the use of bamboo floats or booms under the end being towed, which prevented the latter from dipping under water and thus offering a great resistance. The float was not sunk with the mattress, but was pulled out by the tug as soon as the site for sinking was reached.

The proper line to be taken by the wall had been marked out by temporary dolphins, and to the difficulties experienced with these we shall have occasion to allude later. Meanwhile we will describe the process of sinking the mattresses. It should be explained that the Port Authorities own a large suction sand dredger—the construction of which, by the way, we described in our issue of May 15th, 1908, while its work at Rangoon was referred to and illustrated in our issue of July 16th, 1909—and that for carrying the discharge piping for this dredger there are numerous circular steel pontoons. Four of these pontoons were required for sinking a mattress, and they were duly moored in correct position, the line being taken from the dolphins. Each pontoon had two winches fitted on its deck, and each was large enough to accommodate a gang of coolies. Attached to one of the anchors on each pontoon was a 5in. Manila rope, which was paid out along with the anchor chain and fixed temporarily to the bollard of the pontoon. The mattress was pulled in between the four pontoons and the mooring ropes were doubled through the mooring loops and secured with hard wood toggle pins, the ends of the mooring ropes being fixed to bollards on the pontoons. The mattress could, therefore, be moved in any direction by working on the pontoon anchors. During this operation the long and short portions of the mooring ropes were adjusted by turning the toggle pins in the loops by hand. The short lengths of the mooring ropes thus moored the mattress in position, while the longer lengths served as guides during the time that the mattress was sinking.

Fig. 4—VIEW SHOWING INFLUENCE OF WALL BEFORE COMPLETION

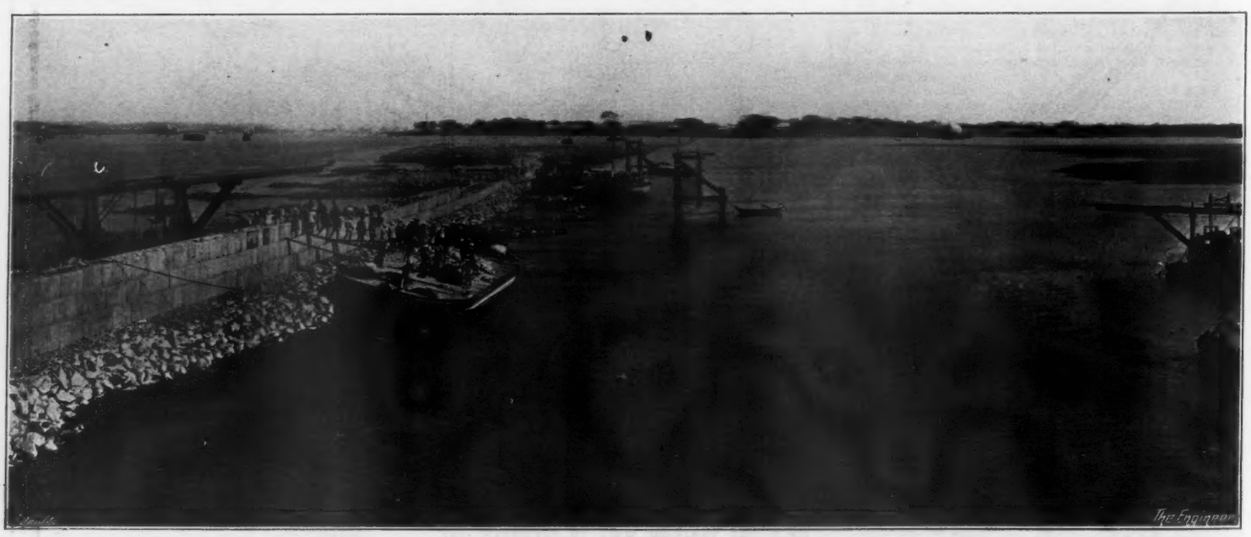


Fig. 5—BUILDING THE SUPERSTRUCTURE

When the mattress had been got into its correct position stone barges were anchored on each side of it and moored to it by ropes. The coolies then rapidly covered the whole of the surface of the brushwood with stone, commencing operations from the centre and working to the edges. As, of course, the

coolies had to pass backwards and forwards over planks from the barges to the mattress with the stone, it was desirable that there should be as little relative motion between the boats and the mattress as possible. Hence slack water time—generally at high water—was chosen. It required about 80 tons of stone to sink each mattress, but a good deal more than this was used, 300 tons at least being always deposited. As the mattress was allowed to sink by paying out the ropes on the pontoons stone barges were drawn over it and coolies flung out stone as quickly as possible. Then when the mattress reached the bottom and its lowering ropes were cast off more stone was deposited from further barges, drawn over the site by their own anchors and winches.

The quickness with which the sinking of a mattress was carried out is a matter for some wonder and reflects considerable credit on those in charge of the arrangement. As a general rule only about twenty minutes were required for the process and from 120 to 150 men were employed. As Mr. Buchanan explains, the work was hard and anxious for all concerned, and the quickness to which we have drawn attention was by no means unnecessary. As can be well imagined, the mattresses were unwieldy to tow, and if they were moved too soon before slack water there was a danger of the current getting hold of them and overpowering the tugs. If, on the other hand, they were moved too late after slack water they might be caught by the ebb tide and overturned when sinking. It is wonderful, therefore, when the difficulties are considered, that out of the whole number of mattresses necessary to cover an area some two miles long by 230ft. wide, only two got out of control and had to be sunk out of line.

A commencement was made in the sinking of the mattresses in February, 1910, and, as originally intended, the process was not to have been completed till January, 1913. But as the work went on the advantages of accelerating became evident, and accordingly steps were taken by which the last mattress was laid in July, 1911—or some eighteen months ahead of the date originally proposed. This quickening of the work was rendered possible by the construction of a further mattress building slip rather farther down the river. We may add that one of the principal factors considered in expediting the work was the difficulty of conducting operations during the time of monsoon.

We mentioned above that in order to mark the line of the wall temporary dolphins were used. These were small timber piers erected 500ft. apart. For their construction a local wood known as *thingan* was used, and it was said of it that it would successfully resist the sea worm, or *teredo navalis*. As a matter of fact, this was very far from being the case, as in four months the underwater portions, which were formed of 14in. by 14in. timbers, were eaten right through and the dolphins began to collapse. They were then rebuilt with the same kind of timber sheathed in zinc, after which no further trouble of the kind was experienced.

When the whole carpet of mattresses was laid work was commenced on the formation of the training wall proper. This was done by dumping stone from 1000-ton steam hopper barges, which, first of all, deposited stone over the whole surface until there was an average depth of it throughout. The steamers then confined their attention to piling up stone on the wall proper, the centre line of which came practically at the junction of two of the 75ft. wide mattresses, as will be seen from our engraving, Fig. 3, which we reproduce from our issue of November 24th, 1911, with the modifications in it which have been since introduced. It was originally intended that the wall should only be built up to 3.4ft. above low water of ordinary spring tides, but it was found that this was not high enough, as the water backed up and flowed over the crest of the wall with such violence as to cause breaches and to render the deposition of silt inside the wall out of the question. The effect of the wall even when in quite an early stage in its construction can be seen in Fig. 4, which shows the old deep-water channel. It was therefore decided to raise the wall by means of three tiers of reinforced concrete slabs arranged one above the other. Each tier was composed of two sets or slabs of concrete laid on their edges parallel to one another and held apart by tie rods arranged to cross one another, the intervening space being filled up with rubble. The distance between the slabs was different in the three tiers, those at the top being nearer together than those at the bottom. The result is that the top of the wall is now 12.4ft. above low water of spring tides and 4.9ft. below high water of spring tides. Altogether 17,000 slabs were required for this work, and the whole superstructure was constructed in less than six months. The slabs were all made on the site by native labour and were got into position by means of a barge provided with a wooden overhanging jib arm fitted with a runner.

At a level 5ft. below the originally proposed top of the wall—that is to say, 2.6ft. below low water of spring tides—the width of the top of the wall is 30ft. This is termed, as will be seen on the engraving, the zero of gauge. The batter of the slope of the wall towards the river is 2 to 1, and on the other side 1½ to 1. Owing to the draught of the stone-carrying steamers, it was not possible to dump stone from them so as to raise the wall to a greater height than low water level, and from this level upwards the stone was deposited by hand from barges specially constructed for the work. Fig. 5 shows the end of the wall at low tide and the building of the superstructure. The width of the base of the wall will be appreciated. On the right-hand side will be seen one of the barges with its overhanging arm and runner used for putting the concrete slabs in position. In all, about one million and a-half tons of stone have been put into the work, the bulk of which has come from quarries on the island of Kalagouk, which, as our readers are already aware, is situated about 135 miles from Rangoon. The work of opening out these quarries, which was begun in 1908, was an operation of great difficulty and considerable magnitude. The island was at first uninhabited, and housing accommodation had to be provided for over 1000 workmen and 22 officers. Arrangements had also to be made for a commissariat, police protection, medical attendance, a conservancy system and a water supply. A loading pier had to be constructed some distance from the shore, since the water was too shallow to permit of the construction of a land wharf, and communication with this was maintained by means of overhead cableways. An output of about 6000 tons of granite per week was maintained during fine weather, but a great deal of trouble was experienced on account of the excessive rainfall, which is always more than 200in. per annum, and sometimes as much as 250in. to 260in., the bulk of it falling in six months. The cableway skips each carried 7 tons of stone, and it was possible to load a 1000-ton vessel in ten hours. Three sea-going steam hopper barges, built by Simons, of Renfrew, were employed in conveying the stone from Kalagouk to Rangoon, and they made the journey in fourteen hours in fine weather. In quarrying the stone the most modern machinery and appliances were employed, these including hydraulic monitors working at a pressure of 60 lb. per square inch and capable of delivering 2000 gallons per minute for removing the overburden. When the steamer arrived on the site of the wall it was carefully manœuvred into position, and the whole of its cargo discharged at one operation. In order to leave these three steamers free for continual dumping, it was decided soon after starting the work to obtain the stone which had to be hand placed from quarries on the Pegu-Moulmein Railway.

It was thought that as the main channel which the river had cut out for itself near the south bank was closed by the wall, it would have been necessary to dredge a new channel for it on the north of the wall. Accordingly the dredger was put to work, but after making several cuts with it, it was found that the river was deepening by natural scour, and this has continued satisfactorily. Equally satisfactory has been the silting up of the area between the wall and the south bank. This is continuing regularly at the rate of about 3ft. per month, and eventually the whole area which is in excess of 300 acres will be reclaimed, and the present training wall will then become the revetment of the land so reclaimed, and, in fact, the south bank of the river.

It is interesting to note that the work above described has been actually carried out at less cost than was originally anticipated. The authorities set out with the expectation of having to spend exactly 150 lakhs of rupees, or £1,000,000 sterling. The actual cost has been 138 lakhs, or £920,000. The following details of this expenditure are interesting:—

*Details of Cost.*

| | Rupees. | £ |
|---|---|---|
| Mattresses | 15,45,000 = | 103,000 |
| Dolphins and beacons | 1,54,000 = | 10,300 |
| Stone | 50,37,000 = | 335,800 |
| Capital cost of quarries and steam hopper barges | 25,72,000 = | 171,400 |
| Equipment at headquarters, i.e., buildings and plant, mattress yards, steam tugs, launches, &c. | 12,65,000 = | 84,300 |
| Purchase of land | 8,97,000 = | 59,800 |
| Dredging plant | 12,19,000 = | 81,300 |
| Dredging | 3,50,000 = | 23,300 |
| Miscellaneous works | 3,28,000 = | 22,000 |
| Engineering and supervison | 4,33,000 = | 28,800 |
| | 138,00,000 = | 920,000 |

Towards this amount the Government of India subscribed a free grant of 50 lakhs, and the remainder was raised by the issue of 4 per cent. debenture loans. As the work is non-revenue producing, it imposes a yearly burden of 6 lakhs of rupees (£40,000) on the revenue of the port. The latter, however, is growing rapidly, and will doubtless continue to grow by reason of the beneficial effect of the training wall and of the other operations which will now be economically possible, so that the burden, although severe, should become decreasingly felt each year. Moreover, it is reasonable to expect that in due course a certain amount of revenue should be derived from the reclaimed land. In any case, the whole undertaking reflects the greatest credit on Mr. Buchanan and on those who have ably assisted him in bringing it to a satisfactory termination. It should be mentioned, in conclusion, that Messrs. P. W. and C. S. Meik, the late Mr. J. W. Bell and Dr. Corthell were at various times consulted and reported on the project. The contractor for the supply of the whole of the brushwood was the Bombay-Burmah Trading Corporation; the machinery and cableways at Kalagouk were furnished by Fraser and Chalmers, Limited; and the dredges and steam hopper barges by W. Simons and Co., Limited, of Renfrew.

## THE BONECOURT SURFACE COMBUSTION PROCESS.

No. III.*

LIQUID-FUEL FIRED BOILERS.

Within the past few months the field of application of surface combustion has been considerably enlarged by the successful adaptation of the system to the burning of liquid fuel. For some time past experiments have been in progress in the London works of Bonecourt Surface Combustion, Limited, having this end in view. The difficulties encountered were not inappreciable, as will be realised by all those who have attempted to obtain complete combustion when burning liquid fuel in close proximity to water-cooled surfaces. At first sight it might appear that the idea of hot surfaces accelerating the combustion of liquid fuel involves an element of contradiction. It would seem that the only effect resulting from subjecting an incandescent surface to the action of a liquid would be the quenching of the incandescence. When it is realised, however, that the combustion of liquid fuel is really a case of gaseous combustion, the burning of the fuel consisting in the burning of the gaseous products which result from the heating of the liquid, the feasibility of the proposal to employ hot surfaces in the acceleration of the combustion of liquid fuel becomes evident.

These reflections point the way in which the problem has been solved. The process of burning liquid fuel by the agency of surface combustion consists in injecting the liquid fuel together with the necessary amount of air required for its complete combustion into a chamber of small dimensions in which a partial gasification of the liquid takes place. The particular arrangement employed in the firing of boilers is shown diagrammatically by Fig. 11. The arrangement consists of a fire-clay sleeve situated in the entrance end of the boiler tube, which serves to conserve a certain amount of heat within the chamber thus formed. The chamber is closed at the same end by means of a fire-clay plug, through an aperture in which the oil and air supplies are introduced. It is closed at the further end by a

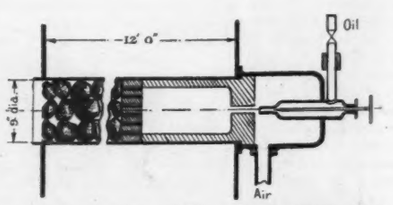



Fig. 11—BONECOURT LIQUID FUEL ARRANGEMENT

perforated septum, through which the gaseous products pass from the gasification chamber into the refractory packing in the boiler tube. The arrangement is simple and self-contained, each boiler tube carrying its own gasification chamber and refractory packing for the acceleration of the combustion.

Fig. 12 is from a photograph of a boiler which has been put down in the London works of the Bonecourt Company, and which has been successfully fired with liquid fuel on the principles above described during the past few months. The boiler is in continuous operation by day, supplying the works with power. The air required for the combustion is supplied by means of a fan developing a pressure of 35in. water gauge. The oil is fed to the tubes from overhead, no pressure being employed other than that due to a head of about 12ft.

The boiler is 5ft. in diameter and is 12ft. long, and is fitted with five boiler tubes each 9in. in bore. The device employed for delivering the oil to the tubes is such that no steam or air pressure is required to effect the spraying of the liquid, this being accomplished by the rapid flow of the air delivered into the gasification chambers under a pressure which may vary at will from 5in. to 30in. water gauge or more.

Each fire-clay plug is furnished with a sight tube, which gives a good view of the state of the gasification chamber. The operation of lighting the boiler occupies three minutes, and consists in swinging aside the sight tubes, inserting some lighted oily waste, and turning on the oil and air supplies. In a few moments the gasification chambers become red hot. The oil and air supplies are then adjusted until a uniform incandescence is obtained in each, a little experience sufficing to enable the operator to adjust the supplies in the correct proportions by observation of the glow produced. With this particular boiler steam at 110 lb. per square inch is obtained in 50 minutes, starting all cold.

That the function of the chamber is to gasify the oil and not to burn it completely is proved by analyses which have been made of samples of the gaseous products drawn from a point within the boiler tube situated immediately beyond the gasification chamber. An analysis of these samples has shown that the gaseous medium leaving the chamber is a mixture of air and combustible gas, a certain proportion of products of combustion being also present, owing to a partial combustion of the fuel taking place within

* No. II. appeared May 22nd.

the chamber, such partial combustion being necessary to maintain the temperature of the chamber.

The following are the results of a test which has been carried out on this boiler :—

| | |
|---|---|
| Steam gauge pressure, per square inch | 110 lb. |
| Temperature of oil | 80 deg. F. (27 deg. C.) |
| Air pressure | 37in. w.g. |
| Pressure in smoke-box | 3in. w.g. |
| Temperature of combustion products leaving boiler tubes and entering feed-water heater | 608 deg. F. (320 deg. C.) |
| Temperature of combustion products leaving feed-water heater | 275 deg. F. (135 deg. C.) |
| Temperature of cold feed | 43 deg. F. (6 deg. C.) |
| Temperature of feed from feed-water heater to boiler | 119 deg. F. (48 deg. C.) |
| Duration of test | Three hours |
| Total water evaporated | 7625 lb. |
| Water evaporated per hour | 2542 lb. |
| Water evaporated per hour from and at 212 deg. F. | 3085 lb. |
| Total tube surface (five tubes 9in. bore, 12ft. long) | 141 square feet |
| Total heating surface of boiler | 123.7 square feet |
| Steam raised per square foot of heating surface per hour from and at 212 deg. F. | 25 lb. |
| Total oil burned | 545 lb. |
| Oil burned per hour | 181.7 lb. |
| Water evaporated from and at 212 deg. F. per pound of oil | 17.0 lb. |
| Net calorific value of oil, per pound | 17,800 B.Th.U's. |

$$\text{Efficiency} = \frac{7625 \times 1175.9 \times 100}{545 \times 17,809} = 92.5 \text{ per cent.}$$

It will be seen that the result of this test shows the boiler to possess an efficiency of 92.5 per cent., calculated on the net calorific value of the oil, when evaporating at the rate of 25 lb. of water from and at 212 deg. Fah. per square foot of heating surface per hour.

A continuous sample of the combustion products taken during the test was found to analyse :—

| | Per cent. |
|---|---|
| Carbon dioxide | 12.8 |
| Oxygen | 3.4 |
| Carbon monoxide | 0.0 |
| Nitrogen | 83.8 |
| | 100.0 |

A careful examination of the combustion products was made to determine the presence, if any, of carbon monoxide or hydrogen or other gases resulting from partial combustion, but none such were found.

The oil burned in this boiler is the ordinary class of fuel oil, as used for steam-raising purposes on torpedo boats and for steam raising and furnace firing generally. Experiments have been made with various classes of fuel oil, and with each kind successful results have been obtained. Where the oil is of so viscous a nature as not to flow readily at atmospheric temperatures it is found necessary to warm it sufficiently to produce the required readiness of flow.

The points which, it is claimed, characterise this boiler may be enumerated as follows :—

(1) Complete combustion of the oil, no products of partial combustion being found in the flue gases.

(2) The air required for complete combustion of the oil is only slightly in excess of the theoretical requirement.

(3) Entire absence of smoke once the boiler has been started up, and practically no smoke while starting.

(4) The oil is supplied to the boiler cold and at a very low pressure, the air supplied for the combustion being sufficient to effect the necessary spraying of the oil.

(5) The combustion products are cooled down to a point below which further cooling would scarcely be practicable or economical.

(6) An evaporation of 25 lb. of water per square foot of heating surface per hour.

(7) The effective transmission to the water in the boiler of 92.5 per cent. of the net heat available in the oil burned, even when evaporating at the above stated high rate.

(8) Exact and immediate regulation of steam production.

The temperature and composition of the gases leaving the system being known, and due regard being paid to the content of water vapour in the products of combustion, it is a relatively simple matter to calculate the sensible heat leaving the system in the chimney gases. Taking for the purpose of the calculation the figures which have been obtained by Le Chatelier for the specific heats of the gaseous constituents at various temperatures, it is found that the heat leaving the system with the chimney gases amounts to 5.2 per cent. of the heat originally available from the combustion of the oil. Making the necessary distribution of heat utilisation as between the boiler proper and the feed-water heater, the following scheme is obtained as expressing the distribution of heat utilised and lost throughout the system :—

| | Per cent. |
|---|---|
| Heat transmitted through boiler tubes | 83.7 |
| Heat transmitted through tubes of feed-water heater | 8.8 |
| Heat utilised | 92.5 |
| Heat lost in products of combustion at 135 deg. C. | 5.2 |
| Balance, being radiation loss | 2.3 |
| Total heat available in oil burned | 100 0 |

By way of confirming, as far as possible, the proportionate distribution of heat loss into radiation loss and sensible heat loss in the products of combustion, a careful measurement of the actual radiation loss suffered by the plant was made by shutting off the boiler with an initial steam pressure of 99 lb. per square inch and observing the fall in pressure over a period of two hours. By this means the radiation loss was found to amount to 2.1 per cent., calculated on the heat put into the system with the boiler operating at the rate of output obtaining during the test. It will be observed that the figure agrees very closely with the figure obtained by difference.

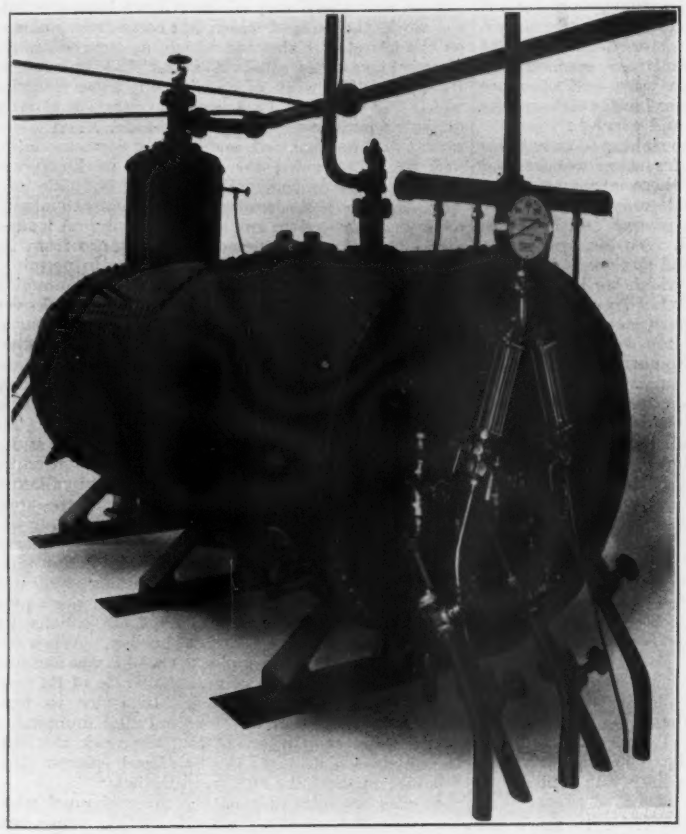


Fig. 12—BONECOURT BOILER FIRED WITH LIQUID FUEL

Although the utilisation of liquid fuel in surface combustion plant is of very recent development, another liquid fuel-fired boiler has been built and is now at work. It comprises a small boiler shell traversed by two tubes 9in. bore and 6ft. long, and is shown by Fig. 13. The products of combustion leaving the tubes are returned through a tube of 6in. bore situated in the steam space of the boiler, steam superheating coils being disposed inside the tube, producing a superheat temperature of 700 deg. Fah.

Boiler construction of this type is not limited to the use of 9in. tubes. Trials have been made with tubes up to 24ft. long and 12in. in bore, an hourly evaporation of 2090 lb. of water from and at 212 deg. Fah. being obtained from a single tube of the last stated dimensions.

SOLID FUEL.

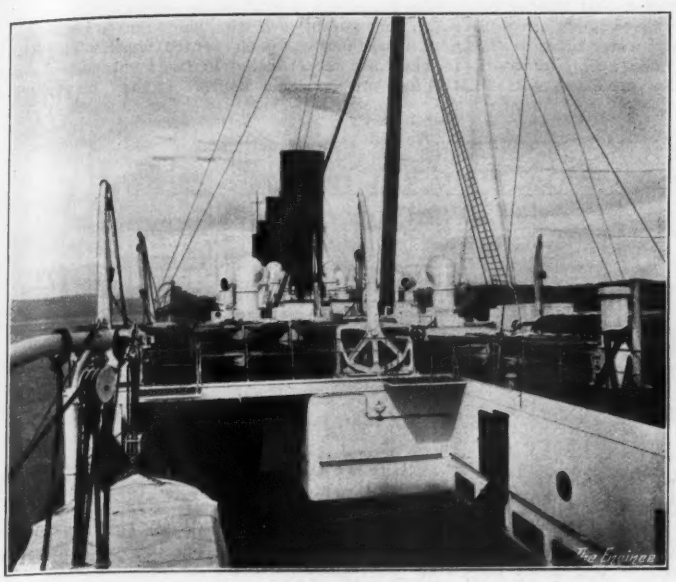
From what we have already said it will be clear that the advantages which are claimed for the application of surface combustion to steam generation are a very high efficiency even while generating steam at extremely high rates of output. The system has now been adapted so that liquid fuel may be burned in Bonecourt boilers as readily as gaseous fuel. There now remains only the field of solid fuel, the largest field of all, to which, if possible, to apply the system. This field of investigation has already been attacked, and although a Bonecourt boiler fired direct with solid fuel is not yet a *fait accompli*, the results which have been attained in this direction afford hope of a highly useful result being obtained at no distant date. The experiments which have already been carried out have produced remarkable results. In a small apparatus fired with solid fuel, evaporating 334 lb. of water per hour from and at 212 deg. Fah., complete combustion of the fuel has been obtained, although the amount of air supplied for the combustion was practically no more than is required by theory, as is shown by the following analysis of the combustion products:—

| | Per cent. |
|---|---|
| Carbon dioxide | 19.1 |
| Oxygen | 1.4 |
| Carbon monoxide | 0.0 |
| Nitrogen | 79.5 |
| | 100.0 |

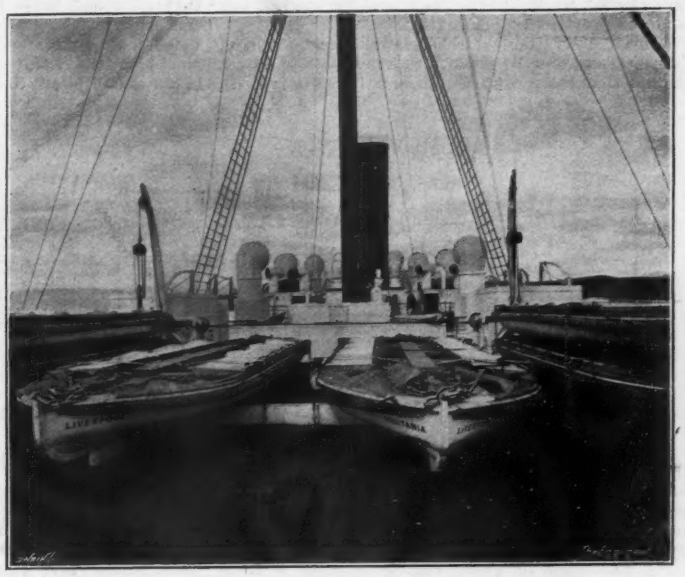
The evaporation produced amounted to 17.8 lb. of water from and at 212 deg. Fah. per hour. Such a result is remarkable from the point of view of both a combustion phenomenon and an evaporation performance. This result was communicated by the Bonecourt Company to their German allies, the Berlin Anhaltische Maschinenbau Aktien Gesellschaft who expressed themselves sufficiently impressed with the results to undertake the further development immediately. They have constructed a coal-fired Bonecourt boiler and are just about to put it under

Fig. 13—SMALL BONECOURT LIQUID FUEL BOILER

# THE CUNARD LINER AQUITANIA



VIEW FROM DOCKING BRIDGE



SOME OF THE BOATS

IN THE GLADSTONE DOCK, LIVERPOOL

fire. This first construction is, naturally, of a tentative nature, but it is hoped that it will pave the way for a considerable enlargement of the field of surface combustion applied to steam generation.

## THE CUNARD LINER AQUITANIA.

The new Cunard liner, the Royal Mail steamship Aquitania, is due to sail from Liverpool to New York for the first time to-morrow. She was launched at Clydebank on April 21st, 1913, so that her fitting-out and trials have occupied just over thirteen months—a truly short time for such an immense ship as this.

Much has already been written about the vessel, her propelling machinery, and her interior fitments. It cannot be gainsaid, however, that in no respect have the problems involved in her design approached in difficulty those which had to be faced in the case of the Lusitania and Mauretania. Indeed, with the data collected after these two vessels had been in service for a few years the task of designing the Aquitania was one of comparative simplicity. The chief problem was a commercial one. The Lusitania and Mauretania, as is well known, each earn a substantial subsidy from his Majesty's Government. The new vessel does not, and in this fact we have the clue to all the principal points of difference between her and her elder sisters. It was desired that the new vessel should earn as much per voyage without a subsidy as the older boats did with their subsidies, and that she should be able to sail regularly from each terminal port once in every three weeks.

To make up for the absence of the subsidy it was decided that the new vessel should have a lower speed and a larger passenger carrying capacity than her forerunners. In order to avoid the necessity for an expensive and hurried turning round at New York and Liverpool it was not desirable that the ship should take longer than 5½ days on the voyage from port to port. This necessarily restricted the amount by which the speed could be lowered and practically fixed it at 3 knots less than that of the older vessels, namely, at 23 knots. The passenger accommodation had therefore to be increased until the saving of coal, upkeep costs, &c., represented by the lower speed, together with the extra passenger earnings, equalled the subsidy earned by the sister ships. To provide this additional accommodation the new vessel was given an extra deck and her length was increased by over 100ft. For the sake of stablility corresponding increases had to be made in the beam and depth.

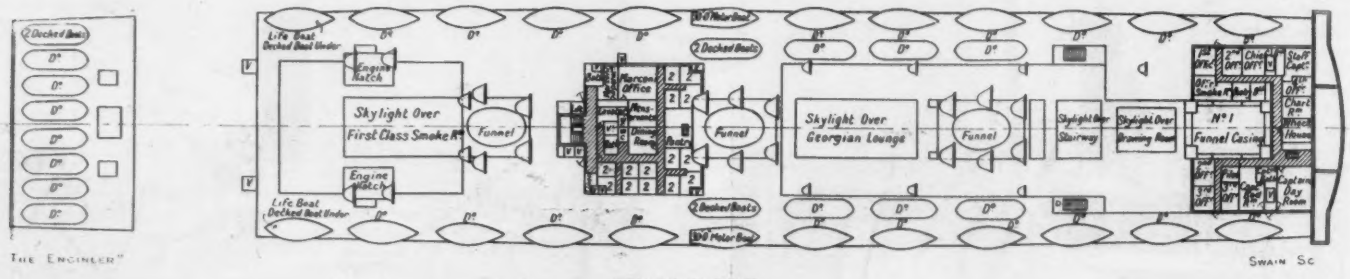
In view of this brief account of the genesis of the Aquitania, it may be of interest to compare certain of her dimensions, &c., with those of the Mauretania. This we do in the following table:—

| | Aquitania. | Mauretania. |
|---|---|---|
| Screws | Quadruple | Quadruple |
| Turbines | Triple-expansion | Compound |
| Shaft horse-power | 56,000 | 72,500 |
| Sea speed | 23 knots | 26 knots |
| Moulded length | 865ft. | 760ft. |
| Moulded breadth | 97ft. | 87½ft. |
| Moulded depth | 64½ft. | 60½ft. |
| Draught | 34ft. | 36¼ft. |
| Displacement | 49,430 tons | 41,550 tons |
| Tonnage, gross | 47,000 | 30,704 |
| Tonnage, net | 17,500 | 12,800 |
| Weight, hull | 29,150 tons | 19,758 tons |
| Weight, machinery | 9,000 tons | 9,402 tons |
| Total deadweight | 11,280 tons | 12,390 tons |
| Coal capacity | 6,000 tons | 6,354 tons |
| Passengers carried | 3,230 | 2,150 |
| Crew carried | 972 | 850 |

It will thus be seen that the Aquitania is a considerably larger vessel than the Mauretania. She provides accommodation for 1202 more people, made up of 48 first-class passengers, 154 second-class passengers, 878 third-class passengers, and 122 in the crew. Yet in spite of this very material increase

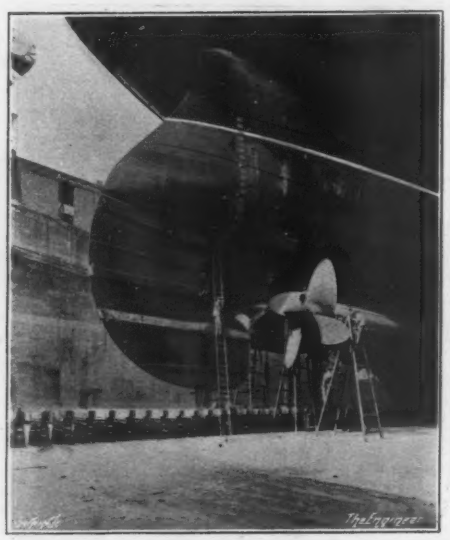
in her accommodation, she may be expected to consume slightly less coal on the voyage across the Atlantic, though the voyage will take about twelve to fourteen hours longer. These considerations show very clearly, we think, the price paid for the last few knots of the Mauretania's speed.

A brief description of the general construction of the ship may now be given. Starting with the hull, we find that the overall length is 901ft., the breadth




THE BOAT DECK

97ft., and the depth to the boat deck 92ft. 6in. A double bottom extends from the bow to the stern and has a uniform depth of 5ft. 4in., except in the turbine room, where it is increased to 6ft. 3in. The double bottom is divided into forty-one water-tight compartments—each of which can be emptied or filled separately—and is extended at its maximun depth to the turn of the bilge in order to accommodate the bed-plate girders carrying the wing turbines.



STERN OF THE AQUITANIA

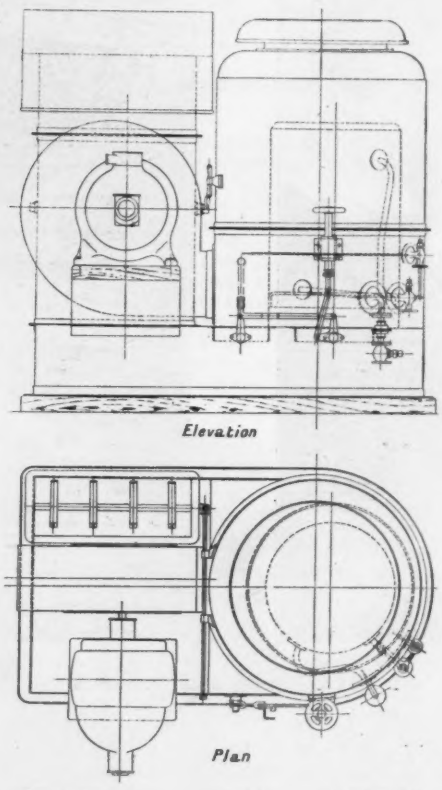
The hull is divided into eighty-four water-tight compartments, not counting those in the double bottom. The transverse bulkheads are sixteen in number, and extend in some few cases to 9ft. and in the remainder to 19ft. above the load water-line. In the turbine-room there are two longitudinal bulkheads. In the central of the three compartments thus formed the machinery driving the two inner propeller shafts is situated, while in the wing compart-

"A" DECK, LOOKING AFT

ments the wing turbines are isolated. The condensing plant room is divided into two by a central longitudinal bulkhead. In the boiler-room, which has a length of 450ft., a fore-and-aft bulkhead is arranged on each side of the space, so that in this region, where the compartments are largest, there is "a ship within a ship." These bulkheads are 18ft. from the outer skin of the vessel and the space thus formed is utilised, as is usual in Cunard liners, for coal bunkers. The bunker space on each side is divided into ten water-tight cells by means of transverse bulkheads. An anti-rolling tank is worked into the ship structure at this point and takes the place of a coal bunker on each side. The hatches to the cargo holds are provided with trunks and are made water-tight to the height of the weather deck. The bulkhead doors below and adjacent to the load line are fitted with the Stone-Lloyd quick-closing hydraulic gear. There are forty-five of these doors.

There are nine decks all told in the vessel, six of which are within the moulded structure, while three are superstructure decks. The lower orlop deck is only partial and extends ahead of and abaft the machinery spaces. Of the superstructure decks the first has a length of about 640ft., the second one of 624ft., and the third or boat deck one of about 464ft. Further aft a deck-house forming part of the second-class quarters is made use of for carrying additional boats on the same level as the boat deck itself.

The propelling machinery derives its steam from twenty-one large double-ended boilers, each with eight furnaces. The total grate area of these boilers is 3542 square feet, and their total heating surface 138,596 square feet. The boilers are capable of generating 9600 tons of steam per day at a pressure of 195 lb. per square inch. Forced draught is sup-



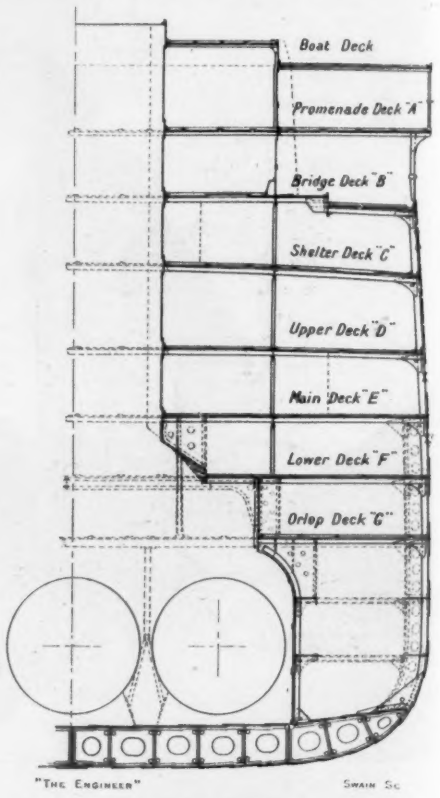

THERMO TANK HEATING UNIT

plied to the stokeholds by twenty-eight fans, 66in. in diameter, and driven in pairs by fourteen 50 horse-power electric motors. The boilers are arranged in four water-tight compartments, three of which contain six and the fourth three boilers. Four elliptical funnels are provided, measuring 24ft. by 17ft. in cross section and with the tops 160ft. above the level of the boiler fire-grates. For handling the boiler ash seven expellers are provided. The pumps for them are driven by steam turbines and can be used as bilge pumps in case of emergency. The ash-expelling plant has to deal with about 1200 tons of material during the round voyage.

Directly aft of boiler-room No. 4 is the turbine-room, which, as already remarked, is divided into three compartments. The turbines are of the Parsons reaction type. The most noticeable feature in connection with them is the departure from the compound expansion found in the Lusitania and Mauretania and the adoption of triple-expansion. The high-pressure turbine is situated in the port engine-room, the intermediate in the starboard, and the two low-pressure turbines in the central engine-room. The astern turbines are arranged for compound expansion, there being a separate high-pressure astern turbine on each wing shaft and a low-pressure astern turbine on each centre shaft. The latter turbines are incorporated in the low-pressure ahead turbines on the same shafts. It may be remarked that there are over a million blades in the main turbines and that they range in height from 1½in. to 20in.

Aft of the engine-room is the condensing plant. The total cooling surface of this is about 46,000 square feet, provided by some 18,700 tubes. The cooling water used amounts to 18,500 tons per hour.

The starting platform is situated at the forward end of the central engine-room. Here, besides about 120 gauges and indicators of various kinds, are situated the hand levers controlling the manœuvring valves. These valves weigh about 25 tons each, and are each operated by means of a separate small steam engine. The valves in case of emergency can also be moved




MIDSHIP SECTION

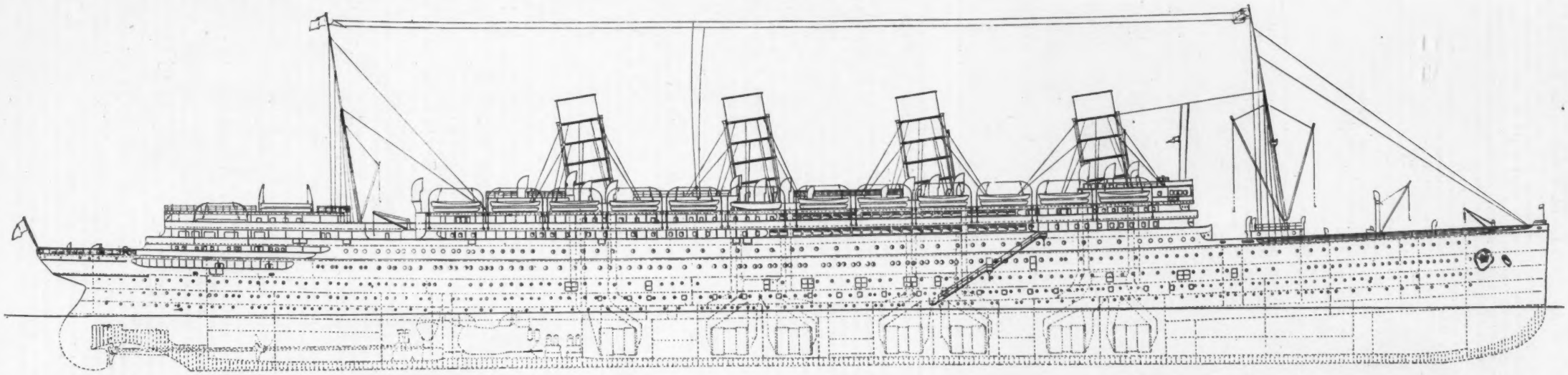
by hydraulic power if necessary. The firing of the boilers is controlled from the starting platform by the sounding of an electric gong in the boiler-rooms. The eight furnaces in each boiler are fired in rotation, an automatic indicating arrangement being provided whereby numerals are made to appear on a dial. The starting platform is in direct communication with the chief engineer's office, which in turn is in communication with the bridge, the steering gear engine-room, the electric light engine-room, and other departments and offices. From the chief engineer's office not only is the propulsive machinery controlled, but from it nearly all the machinery and mechanical appliances throughout the ship are looked after. The vessel carries an engineering staff of thirty-four officers and 350 men. Of the officers, something like ten are employed solely on plant other than the propelling machinery.

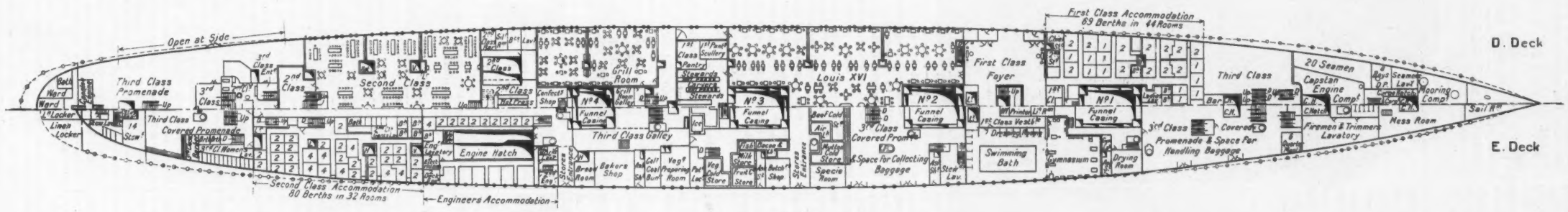
The ventilation and heating arrangements for the passenger accommodation are carried out on a very complete scale. The Thermotank system has been in general adopted throughout the ship. By means of this system the accommodation is thoroughly ventilated and warmed in winter time and ventilated and cooled in hot weather. The Thermotank heating units, a diagram of one of which is given herewith, draw in cold air by means of electrically driven fans

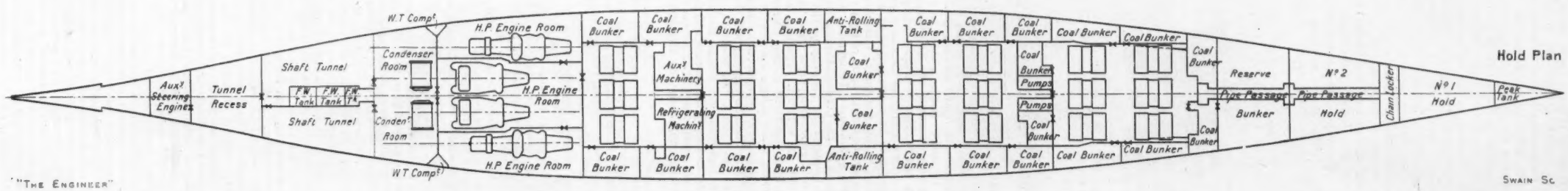
# THE CUNARD LINER AQUITANIA

JOHN BROWN AND CO., LIMITED, CLYDEBANK, BUILDERS

(*For description see page 587*)






"THE ENGINEER" SWAIN Sc.

and heat this air, if required, by passing it across tubes through which exhaust or live steam is passing. There are about 100 of these units throughout the vessel. In addition, there are about fifty fans provided for exhausting foul or vitiated air into the open, while steam radiators are employed in certain places to supplement the hot air if required. The arrangement is capable of handling 12 million cubic feet of air per hour, or, in equivalent terms, of changing the air six to ten times in the same interval.

As a concession to popular demand boats for all on board have been provided. These, as will be seen from the accompanying engraving of the boat deck, are partly of the ordinary lifeboat type and partly of the collapsible sides type. There are twenty-eight pairs of davits, some of which are of the usual swan-neck pattern and the rest of the Welin type. The vessel also carries two large motor boats 30ft. long and 9ft. 6in. in breadth. These are fitted with wireless telegraphy apparatus and are each driven by a four-cylinder 30 brake horse-power Thornycroft paraffin motor.

We have endeavoured to give a brief outline only of the principal features of technical interest of the ship. To describe her in full is more or less unnecessary, as, after all, she does not represent any such great departure from standard practice as did, say, the Carmania or the Lusitania and Mauretania. We hope, however, in a future issue to deal more fully with certain features of the vessel of special interest to engineers and naval architects. Accompanying this article we give several views of the vessel, including some taken while she was in the Gladstone Dock at Liverpool for overhauling preparatory to being handed over to her owners. We also give on page 589 some plans showing the deck arrangements of the vessel.

## ENGINEERING PROGRESS ABROAD.

### Argentina.

The severe competition which has long been taking place in the important town of Tucumán between the River Plate Electricity Company and the Hydro-Electric Company—of Tucumán—has now come to an end, owing to an arrangement between the two concerns. Hitherto, the rivalry has resulted in neither enterprise making any money, but, according to the new arrangement, the business ought to be conducted upon a profitable scale. The Hydro-Electric Company, moreover, owns certain concessions for the construction of light railways or tramways in the province of Tucumán; these will now be taken in hand by the Cordoba Central Railway Company, which has acquired the majority of the share capital of the Hydro-Electric Company. The Cordoba Central Railway has, as a result, organised a new company, which has been registered in this country, and this will acquire among other things the electric lighting station and business hitherto carried on by the Hydro-Electric Company. The Cordoba concern will, hereafter, become possessed of the whole of the electric lighting and power business in Tucumán, but the Hydro-Electric Company will continue to supply the current and power. A certain amount of new equipment will be ordered so as to complete the electric system, while the tramway system is also to be extended.

The extreme activity of German commercial agents in South America has before now been commented upon, and day after day proves how successful are these efforts, in the majority of cases, and how severe is the competition which English and United States houses have now to face. The latest information to hand is to the effect that a large firm of pipe manufacturers, of Gelsenkirschen, has received an order from Buenos Aires for the supply of pipes representing a value of £450,000, while, to a Leipzig firm of engineers, an order for three large travelling cranes, part of the equipment of the new naval port of Bahia Blanca, has been awarded.

In Chile also, German firms are making considerable headway, an order for twenty-four cranes for Valparaiso harbour having recently been booked by the Valparaiso agent of the Deutsche Maschinenfabrik, of Duisburg.

### Brazil.

Owing to the severe financial restrictions which obtain in Brazil at the present time, and the ardent desire of the Federal authorities to keep down expenditure upon public works to the smallest figure, a temporary cessation has taken place in engineering enterprises, and only the most urgent undertakings are being proceeded with. Among these latter, however, are the laying of the water mains of the city of Rio de Janiero and suburbs; an extensive driveway to be known as the "Atlantic Avenue" is also being constructed along the shores of the Copacabana and Ipenemá beaches, with the object of connecting with Rio Branco-avenue, and establishing a continuous thoroughfare, several kilometres in extent, along the bay and the Atlantic. The Government of Brazil has found the necessary amount of £3100 for the purchase of a number of military aeroplanes for the army, and the order has been placed in England through the Chief of the Brazilian Naval Commission, who is now in London. It may be mentioned that in December of last year a shipment of eight monoplanes, three biplanes and three seaplanes was received at Rio for the Brazilian Military Aviation School there. The members of the Brazilian Federal Government are also keen supporters of automobilism, there being no fewer than 400 motor cars in the service of the Government in Rio alone.

A considerable amount of new work in connection with local light and power is to be undertaken by the City of Sao Paulo Improvements and Freehold Land Company, Limited, of which Lord Balfour of Burleigh is the chairman. During the year the company has formulated and submitted to the different Brazilian railways proposals for the construction of a line of railway to serve its various properties, and alternative routes have been surveyed and estimates made for this purpose. The Municipality of Sao Paulo has also decided to construct a large reservoir at Lapa.

### Chile.

It is to be regretted that British contractors pay so little attention to—or receive so little information concerning—the many muncipal engineering contracts which are disposed of by the South American States during the course of the year, and regarding which there seems to be no one sufficiently interested to keep them well-posted. If one looks for such information in the generality of the consular reports, one looks in vain; or, if the intelligence be obtainable at all, it is usually so stale that foreign competitors, whose sources of information are infinitely better organised than ours, have had several weeks' or even months' start, with the inevitable result of first attention. Notwithstanding the fact that in the majority of cases—so the statement is made—"all tenders will be opened and considered upon the same date," we all know that there are many advantages to be derived from being the first in the field. An example is afforded by the absence of any prominent British contractor from among the several firms who have entered for the considerable municipal contracts now being arranged by the Antofogasta authorities. These, together, amount to about £200,000, there being street paving and road making to the value of £136,000, sidewalks £20,000, garbage destructor £8000, public baths £2000, and the erection of a large public market. United States' firms have been particularly active in competing for the work now being offered, and one very enterprising agent went to the trouble of digging up from the streets of San Francisco, where it had lain for several years, a large piece of paving known as "Bitulithic," of which, by the bye, there have been some 30,000,000 square yards laid in the United States and Canada. Armed with this chunk of paving, the agent of the United States Paving and Improvement Company came to Antofogasta to convince the municipal authorities of the value of his manufacture. It has been said that it is no proof that a house is well-built because a specimen brick seems to be all that a brick should be. Apparently, the same argument does not apply to patent pavements, because the municipality of Antofogasta appears to be so well pleased with the American company's specimen of street pavement that the order for the £136,000 job is likely to go to that company. So that there should be no doubt as to the genuineness of the sample submitted, it was cut out of a section in a public thoroughfare, and in the presence of the Chilian Consul in San Francisco—there is no record of what the municipal authorities of that city were doing when the piece of pavement was being removed—officially sealed, and thus borne triumphantly to Antofogasta. Such original enterprise deserves to succeed, and it probably will.

There should, however, shortly be a further and even more important opportunity offered to British contractors, for the Government of Chile intends to ask for tenders for the construction of port improvements at Antofogasta, the cost of which will probably amount to 20,000,000 gold pésos, or, say, about £1,460,000. It is to be hoped that upon this occasion British firms will compete, and in view of the high estimation in which British engineering work is held throughout Chile, there seems no reason why the contract—or at least a portion of it—should not be secured by one of our home firms.

### Ecuador.

A very important contract has just been signed between the Government of Ecuador and the well-known German firm of Orenstein and Koppel, of Berlin. This is for the construction of a line in connection with the main track of railway between Ambato and San Antonio. The work really calls for two branches—the Huigra–Cuenca and the Quito–Ibarra–Esmeraldas—both of which are to serve as feeders to the Quito and Guayaquil Railway. The same German firm of contractors has secured a tentative contract for a further railway undertaking, namely, a line from the capital of Quito to some port in the province of Esmeraldas, which, however, is just now in the throes of a violent revolution against the Government. Apparently, the German firm mentioned considers this no drawback to its enterprise, although to which party it is to look for payment when, and if, the contract is carried out, is a question which will have to engage its attention at some time or other. The projected railway will extend over 300 kilomes., and will have to be built through virgin forests, entailing an immense amount of peon labour, which is by no means easy to obtain in Ecuador at the present time.

The Government and contractors have also in view a railway extension north from a place called Ibarra, passing through the town of Tulcan on the Ecuadorean–Colombian frontier, and tapping the rich Pasto region of Colombia. The country between Pasto and the Pacific Coast is of such a character that railway construction is practically impossible, one river—the Payta—for instance, dropping down from the Andean plateau through a cañyon 15,000ft. sheer. The natural outlet for this Pasto region railway will, therefore, be southward through Ecuador, and then westward to the coast. The maximum gradient will be approximately 3½ per cent., although nothing like a scientific survey of the region has as yet been made.

A United States firm of engineers has secured the contract for the construction and equipment of a line of electrical tramways in Quito, and the whole of the supplies are coming from the United States, including the heavy steel rails, of which 160 tons have already been received. The engineer in charge, Mr. Ellis, also built the electric trams in the city of Caracas, Venezuela, one of the best-equipped lines in South America.

There are many other engineering enterprises awaiting development in the republic of Ecuador, but in view of the extremely unsettled conditions politically, and the propensity of one party to repudiate the solemn engagements entered into with foreigners by another, contracting firms would do well, in our opinion, to keep out of the competition at present going on for Government and municipal work in the republic. There are many suitable contracts being offered by other Latin-American States which are subject to considerably less risk. Neither Ecuador nor Mexico can be said at the present time to offer much inducement as a field for engineering enterprise.

### Egypt.

In January last Mr. Holt, the ex-President of the Association of Engineers and Architects, made a thorough examination of the Assouan Dam, and as a result of his investigation he has recently announced that when the reservoir stood at 113.50—that is to say, 30 cm. above the sill of the spillways—notwithstanding this extreme pressure, all the seepage that was apparent was a dampness in a few places on the down-stream side. The distinguished engineer refutes entirely, and in the most categorical manner, the statement which has been made by certain parties that the Dam "leaks like a sieve" and that "it had partially settled." Mr. Holt shows that leakage must always occur in all dams, and proves that that which takes place in the Assouan structure amounts to very much less than that registered upon other famous irrigation works. In a word, Mr. Holt is thoroughly in accord with other distinguished engineers who have pronounced favourably respecting the Assouan Dam and the method of its construction. We shall reprint the report in an early issue.

### Panama.

The American firm of railway engineers, Messrs. R. W. Hebard and Co., has secured the contract for the construction of a 3ft. gauge railway from the seaport of Pedregal, situated on the south coast of the province of Chirique, to the town of Boquete, situated in the valley of the same name. The length of the line will be 50 miles, and there will be a branch line to La Concepción, which will be the terminus for the present. The larger scheme submitted to the Panama Government, which embraced lines of railway in the provinces of Los Santos, Veraguas, and Cocle, as well as the erection of a large power-generating station on a comprehensive scale, has been temporarily abandoned, the estimated cost being found too large for the Government to incur. The total cost of the new railway will work out at £3000 per mile, which compares very favourably with the cost of South American railway construction in general.

## RAILWAY ACCIDENTS DURING 1913.

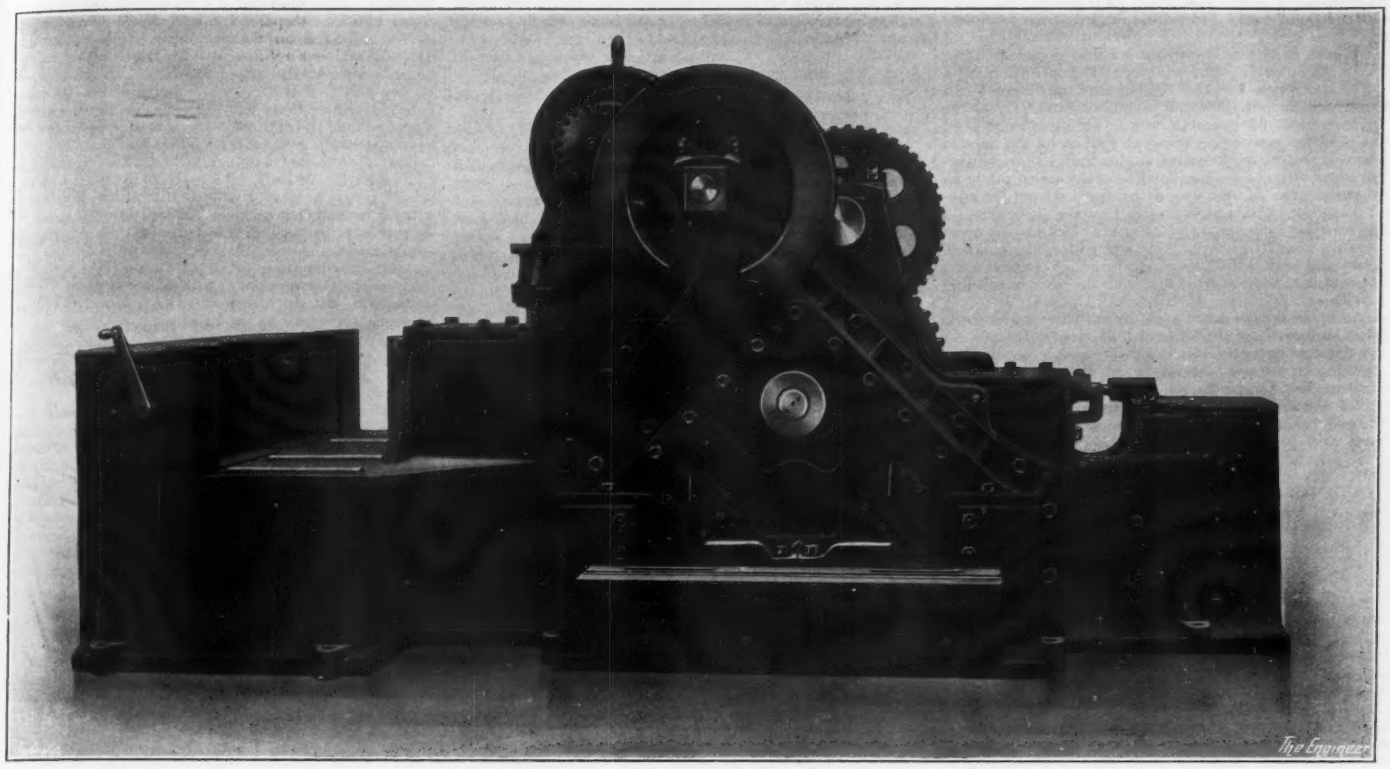
A week ago the Returns of Railway Accidents and Casualties for the year 1913 (Cd. 7405) were published. They showed that 33 passengers were killed and 723 injured in accidents to trains, as compared with the average of 19 killed and 585 injured each year for the ten years 1902–1911, and with the 20 killed and 682 injured during 1912. The number of servants killed in train accidents was 8, while 145 were injured. These compare with an average of 9 killed and 138 injured each year during the ten years 1902–1911, and with 6 killed and 154 injured during 1912. No passenger was killed, but 38 were injured on Scottish railways, and one passenger was killed and 10 injured on Irish railways. Two servants were killed and 17 injured on Scottish railways, and one servant was injured, but none killed, on Irish railways.

But perhaps the most important part of the report, in view of our article last week on "Accidents to Railway Servants" and the inquiries of the Departmental Committee, is that which gives details of the casualties to the servants. By the movement of vehicles, other than in train accidents, 414 men were killed and 5608 injured, and in this class of accident 88 fatal cases and 3172 non-fatal cases occurred in shunting. We will confess that, at first, these figures are disconcerting, as in 1912 the number of fatal accidents was 337 and the figure for 1913 is the highest since 1907. The number of fatal shunting accidents in 1912 was 60, and the figure for 1913 is the highest since 1908. The number of non-fatal accidents of all classes is the highest on record. In 1912 it was 5408, and the highest previous figure was 5577 in 1907. The non-fatal shunting accidents in 1912 was 3070, and the highest previous to 1913 was 3150, also in 1907. Matters are not, however, we find, on further investigation, so black as they appear, as the summary at the beginning of the report shows that the average of fatal accidents for each year for the ten years 1902–1911 was 401; hence the year 1913 was, after all, only 13 above the average. This, however, is not our main hope. Further on in the report is the triennial census as to the number of men employed, which we find was, at the end of 1913, no less than 643,135, as against 608,750 in 1910, when the last census was taken. In this number are included clerks, station masters, carmen, messengers, and other grades, and no figure is given as to the number exposed to danger. This latter figure is reserved for the general report which appears later; but it so happens that the general report for 1910 told us what grades are included under the heading "exposed to danger," and by tabulating these we find that the number exposed to danger was 380,023, representing an increase of 14·7 per cent. over the 331,296 exposed to danger during 1910. Unfortunately, we cannot tell definitely how many were engaged in shunting, so cannot say if the increase from 77 fatal shunting accidents in 1910 to 88 in 1913 is proportionate; but we are able to see that in 1910 there was one man killed out of every 886 exposed to danger, as against one in 920 killed in the apparently bad year of 1913. In 1907 the number was, moreover, one in 775. The increase of 14·7 per cent. in the number of men exposed to danger does not, however, account for the larger number of men injured. This, it is likely, is explained, as we suggested last week, by greater care in reporting accidents in goods stations, engine sheds, &c.

We are now in a position to mention a point we were tempted to bring out last week. This is that the number of accidents is commensurate with the prosperity of the country. When trade is bad men take more time, and when trade is good more men, having less experience, are employed. Reference was made above to the peak points in 1907. That was a year of great prosperity, when the total receipts from all sources for the railways of the United Kingdom was 121½ millions sterling. That year 441 men were killed. There were then a couple of less prosperous years with fewer fatalities, but in 1910 the receipts went up, as did the accidents. In view of these conditions, it was only reasonable to expect that the unusually good times of last year should have been accompanied by an abnormal number of accidents.

# COMBINED PUNCHING, ANGLE-CUTTING, AND BENDING MACHINE

FRANCIS BERRY AND SONS, SOWERBY BRIDGE, ENGINEERS



## COMBINED PUNCHING, ANGLE CUTTING AND BENDING MACHINE.

THE appended illustration represents a powerful electrically driven horizontal punching, angle cutting, and beam bending machine, which has recently been built by the firm of Francis Berry and Sons, Sowerby Bridge, Yorks. It is capable of punching holes up to 1¼in. diameter through mild steel of 1¼in. thick at one end of the machine and at the other end is designed to bend or straighten beams up to 18in. by 7in. The slide at the bending end is made in two parts and is adjustable for different sizes of beams by means of a hand motion. The latter comprises a pair of spur wheels, one of which is keyed on to a large steel screw working in a nut inside the slide, and the two adjusting blocks can be moved across the face of the beam through a distance of from 2ft. to 5ft. 3in. All the three blocks have steel faces let into them and are fitted with friction rollers to facilitate the handling of the work.

As will be seen, the machine is also fitted with double angle shears for cutting angles up to 8in. by 8in. by 1in., either straight or at an angle of 45 deg., and there are means for disengaging both the angle and punch slides. All the gearing is of cast steel and flanged, and the shafts are of special tensile steel and run in gun-metal bearings, the bearings on the first and second motion shafts being adjustable. The machine is driven by a 30 brake horse-power electric motor through spur gearing, the motor being mounted on an entablature on top of the machine as shown.

The weight of the machine is 22 tons.

## A LARGE STEEL WORKS MIXER.

IN a recent issue of the *Zeitschrift des Verein deutscher Ingenieure* Herr Hubert Hermanns described several new designs of pig iron mixers made by the Berlin-Anhaltischen

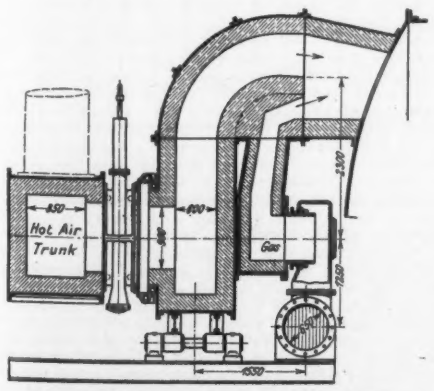



Fig. 1—BURNER FOR ROLLER METAL MIXER

Maschinenbau Company. He pointed out that in addition to the first use of the mixer in securing uniformity of composition of the pig iron by collecting charges from the various blast furnaces, it was now used as a purifier of the molten metal. The change from the old pyriform mixer to the modern cylindrical mixer on roller paths has been brought about by the increased output of steel works necessitating the introduction of mixers of increased capacity. A capacity of 1200 tons has already been reached, and this will probably soon be exceeded in some cases. Special attention has been directed to the question of the most suitable tipping devices, because of the increased charges of pig iron on the one hand, and the diminution and simplification of the tipping operation on the other. The old arrangements for tipping the mixer by means of hydraulic power are gradually being replaced by electric motors, which are preferable for economic and technical reasons. The last stage in the development of the mixer into a refiner is constituted by the shallow hearth mixer (Flachherdmischer), which combines a large surface area with a slight depth in order to obtain the maximum amount of purification. This type of mixer, the capacity of which does not exceed from 250 to 300 tons, is fitted up with heating chambers for air and gas exactly like an open-hearth furnace.

Fig. 2 represents a roller mixer recently constructed by the Berlin-Anhalt Company for a French steel works, which has now the largest mixer plant in the world. It possesses three of these roller mixers, each of which has a capacity of 1200 tons. The mixers are installed in a large building consisting of two halls separated by a row of columns, which support the service staging of the mixers. The metal is brought to the mixer by locomotives on ladle cars, lifted by a crane and tipped into the charging side of the mixer. The mixers are tipped electrically, and ladle cars likewise take the metal away from the pouring side of the mixer. The mixers are heated with coke oven and blast furnace gases mixed with hot air, one of the burners being shown in Fig. 1. The mixer reservoirs are 13.5 metres long and 6.25 metres in diameter. The lining consists of magnesite with a core of fire-clay, and it promotes the mixing of the metal and facilitates the manipulation of the slag. The mixer rests on four roller thrust rings, each with a set of fourteen rollers bearing on frames of malleable cast iron. In order that the tipping device should not be interfered with by stresses in the mixer a middle member is interposed between the gearing and the mixer in the form of a connecting-rod, which acts on the journal by means of a swivel bearing. The connecting-rod is moved by a vertical screw, which passes through a long nut forming the hub of a bevel wheel and rotated by a pinion driven by the motor. The connecting-rod has guides at its upper end.

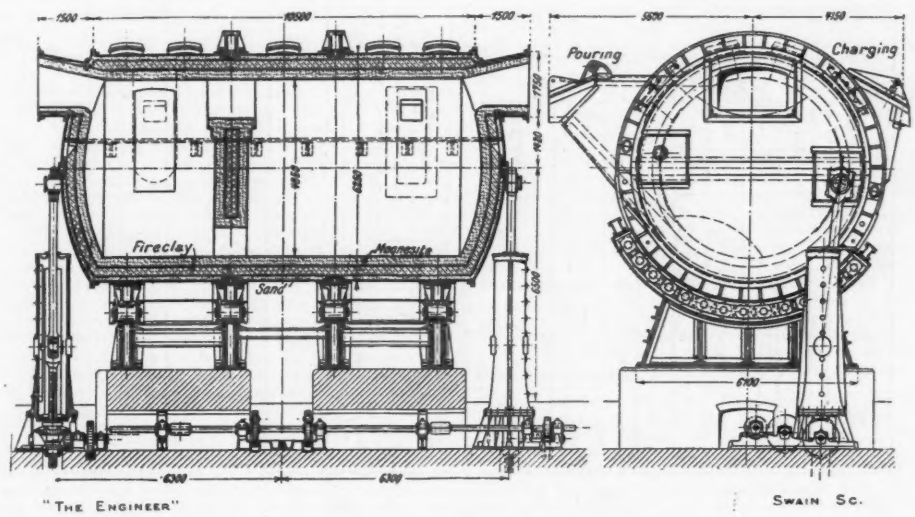



Fig. 2—SECTIONS OF ROLLER METAL MIXER

## THE CANADIAN RAILWAY COMMISSIONERS' REPORT.

THE eighth annual report of the Board of Railway Commissioners for Canada reached us on the 18th instant. It is for the twelve months ended March 31st, 1913, and in view of the frequent references to the Canadian Board at the Royal Commission on Railways, it may be worth while to make some extracts from the report in order to give an idea of the powers possessed by the Commissioners.

The Canadian Commission came into being in 1903. Prior to that the supervision of railways was in the hands of the Railway Committee of the Privy Council. The new body was established on the best features of our Railway and Canal Commission and of the Inter-State Commerce Commission, but larger powers and more executive authority are possessed, for it is both advisory and judicial. The Canadian Board has authority to make every variety of order to secure safety in working, and has equal power in the matter of rates and fares.

While the offices of the Commission are in Ottawa, meetings are held all over the Dominion. We find that during the year in question 102 public sittings were held, of which 42 were in Ottawa, 19 in Toronto or Montreal, and 41 in other places, there being, for instance, a three-

day sitting in Vancouver in July and one of two days there in November. Altogether there were 698 applications heard, and during the year 5751 applications were addressed to the Board and 2785 orders were issued.

It appears that a sum of 200,000 dols. a year for five years, beginning in April, 1909, has been voted towards the protection of level crossings. This money has to go in constructional works and not on maintenance or operation.

As samples of the orders given we find decisions as to fencing a company's right of way; the situation of a station; the rates for the conveyance of cream; an agitation as to a reduction in a telephone tariff; rates for the conveyance of gramophones; shunting charges; heated cars for conveying mineral waters in the winter months; a temporary increase in the charges for demurrage in view of a car shortage. Rules were also made as to the prevention of fires caused by sparks from locomotives; obeying signals at highway crossings; brakes on electric cars; worn flanges of wheels of engines and tenders; a limit of speed of 20 miles per hour, except for tank engines, when running tender first, owing to frequent derailments; signal posts, &c., to be at least 6ft. from the nearest running rail.

Among other things dealt with during the year was the adoption and putting into force of "uniform rules governing the determination of visual acuity, colour perception, and hearing of railway employés on steam railways."

Reference is made to the death of Mr. Mabee, who was the Chief Commissioner, and of whom it is said that, "while appreciating the necessity of certain rules of evidence and precedents in courts, he never permitted legal technicalities to stand in the way of what, in his judgment, he considered fair, right, and just in the interests not only of individuals and associations having resource to the Board for interpretations of their rights, as against railway corporations, but in the case of railway corporations themselves, where their rights, he felt, should be protected against unreasonable and unjust demands." Mr. Henry Lumley Drayton, K.C., succeeded Mr. Mabee as Chief Commissioner.

Accidents to the number of 2547, causing the death of 643 persons and injuries to 2231, occurred during the year. Of these, 621 accidents were investigated by officers of the Board. The 643 persons killed were made up of 21 passengers, 303 railway servants of the companies, and 319 "other persons." Of the 2231 injured, 410 were passengers, 1603 were servants, and 218 "other persons." Three passengers and 16 servants were killed in derailments and 218 passengers and 96 servants injured. Three passengers and 46 servants were killed in collisions and 117 passengers and 136 servants injured.

It is remarked that track conditions are largely responsible for derailments, due mainly to the companies not having increased the strength of the road bed in proportion to the increase in the weight of rolling stock. Collisions, it might be thought, called for the block system, but it must not be overlooked that the majority was caused by breach of rules for working.

## POWER TRANSMISSION BY ROPES.

In our issue of April 17th last we gave a brief abstract of a paper read by Mr. Edwin Kenyon before the Textile Institute on "The Transmission of Power by Ropes." In this paper Mr. Kenyon made reference to the tests carried out by Professor Bonte on rope driving, which agree in the main with the opening remarks of the author. We are now able to reproduce two diagrams—Figs. 1 and 2—descriptive of Professor Bonte's tests, which were first shown by Mr. John Ingham during the discussion. An examination of the curves in the diagrams will suffice to give interesting information as to the connection between velocity and efficiency, and also between loading and efficiency in rope transmission. Fig. 1 shows that with almost any rate of loading the efficiency falls off only very slightly at a velocity of 114ft. per second. This is 34ft. per second higher than the maximum efficiency speed accepted by some engineers who maintain that the influence of the centrifugal action on the rope seriously reduces its power transmitting capacity after this velocity is exceeded. No doubt the tension on the rope due to centrifugal action reduces the permissible effective loading of the rope, but these tests would certainly seem to show that this action does not seriously reduce the efficiency up to a velocity of 114ft. per second, at any rate. With regard to the effect of varying the load, it would appear from Fig. 2 that the overloaded ropes give the highest efficiency, for it will be observed that three ropes loaded with 113 lb. per square inch and running at a velocity of 49ft. per second gave an efficiency of 94 per cent., while with three times this load and running at the same velocity the efficiency seems to have increased by 4 per cent. Mr. Ingham says that practical experience confirms this remarkable result.

## THE SECOND SIMPLON TUNNEL.

*(From our Swiss Correspondent.)*

THE building of the second Simplon Tunnel, with which I dealt in THE ENGINEER for February 13th last, has made such good progress, despite a serious strike and an attempt on the life of Chief Engineer Rothpletz, that the last stone in the high-pressure portion has already been laid. This portion of the tunnel, which is about 46 yards in length, is exactly co-terminous with and parallel to that which gave so much trouble in the first Simplon Tunnel. In 1901, when the borers of the first tunnel entered this part of the mountain, copious hot springs gushed out, making work for the time being impossible, and seven months were required to push the bore through these 46 yards, and eighteen months to complete and line this short length. Only five months, however, have been required for the same work over this portion in the second tunnel. But before it was begun the engineers went all through the high-pressure zone in the first, and strengthened it throughout with strong iron scaffolding.

In view of the opening of the second Simplon Tunnel, the Swiss Federal Railways are obliged to increase the supply of electricity, which, it is estimated, will involve them in an expenditure of £784,000. It is intended to preserve the existing reservoir and the reinforced concrete canal from the Rhone to Brigue. The canal will run into a reservoir of 8000 cubic metres capacity, where the great quantities of sand which it contains in summer, thus considerably reducing the wear and tear on the turbines, will be deposited. The electric power will be carried from the power station to the tunnel mouth and Brigue Station partly by overhead wire and partly by cable. Once the second Simplon Tunnel is in use the turbines of the new power station ought to be able to supply an average of 1150 horse-power and a maximum of 5600 horse-power. In order to do this it is intended to install two sets of machinery, each able to supply 3500 horse-power. As a general rule, one set of machines will suffice to supply all the power necessary on the north side, and the second will be used only in case of an exceptional amount of power being required or the production of power on the other side being interrupted.

## THE ROYAL COMMISSION ON RAILWAYS.

No. XIV.*

THE evidence given before the Royal Commission last week may soon be disposed of. On Thursday, the 21st, when the only members of the Commission absent were Mr. Balfour and Mr. Jackson, Mr. Arthur Andrews and Colonel Claud Hobart appeared to complain of the railway service to and from the Isle of Wight. Comparisons were made between the 108 miles from London to Bournemouth in two hours and the 74 miles to Portsmouth in 1 hr. 50 min. It was suggested that the unsatisfactory service to the Isle of Wight was due to an agreement between the London and South-Western and London, Brighton and South Coast Companies. The witnesses wanted this and all agreements to be made public, and said that at present the only way to wring concessions from the companies was to block their Bills in Parliament, admittedly a very objectionable course. Colonel Hobart complained, in particular, of the want of co-operation among the three railways in the Isle of Wight, and wanted them to be nationalised. "They could not possibly be worse than at present." He thought also that the clauses that forbade railway companies holding land should be eliminated. It was because the companies in the island could not hold their spare land and get "betterment" terms for it that they were in such a bad financial state. Mr. A. D. Peck, of the Lincolnshire Hay Dealers' Association, followed, and showed what facilities had been withdrawn within the last few years.

Lord Derby and Mr. Balfour were absent on Friday. Mr. S. R. Noble, of the National Cyclists' Union, complained of the hardships inflicted on cyclists by the charges for bicycles. Mr. H. F. West, an independent witness, followed. Mr. West was for forty-five years in the goods department of the London and North-Western Railway in the Manchester district, and came to support the nationalisation of railways. Amongst other reforms, he suggested that all charges be prepaid by stamps, as then 70 per cent. of the clerical labour would be abolished. Zone passenger fares would be better for the public and would reduce the clerical work for the companies. Heavy passenger luggage should go by special trains once a day; it was a great cause of delay. Goods rates could be reduced by one-half. When Lord Loreburn pointed out that this would mean a loss of about 30 million pounds a year witness replied that all reductions in cost led to an increase in receipts ultimately. A reduction in passenger fares would also be balanced by an increase in traffic.

After hearing three other witnesses on matters of local interest the Commission then adjourned until Wednesday, June 10th, on which day and the following evidence will be given on behalf of the railways.

* No. XIII. appeared May 22nd.

## JOHN WILKINSON'S MONUMENT.

IT is probable that few of our readers know even of the existence of John Wilkinson's Monument, and fewer still who John Wilkinson was. Yet in his day and his locality he was a man of some moment, and, if it be really true, as claimed for him, that he was the first man to make a boat of iron, he deserves to be remembered. His father, Isaac, was a caster of flat irons in the village of Backbarrow, North Lonsdale, in Lancashire, and he appears to have been born about 1710. Towards the middle of the eighteenth century he and his father built or purchased an iron furnace and forge at Wilson House, Lindale, and attempted to smelt iron ore with peat, and it was for the purpose of bringing this fuel to the furnace that the first iron boat, in reality a barge, was made. It is believed that this very boat now lies at the bottom of a tarn in the moss. Some years later, according to James Stockdale in his "Annals of Cartmel," about 1786, John Wilkinson built a bigger boat, variously given as 40 tons and 70 tons burden, and launched it successfully at Willey Wharf It was named "The Trial," and answered all his expectations. It seems likely that it was used on the Severn, but the references to it are not very clear. Wilkinson commemorated the event by striking medals showing a ship in full sail on one side and his name on the other. It is recorded also that he cast an iron pulpit for a Wesleyan chapel in Staffordshire. He died in 1808, and left instructions, such was his devotion to iron, that he should be buried in an iron coffin which he had made some time before. This coffin, or rather sarcophagus, was too small to contain the actual lead coffin in which his body was enclosed, and another had to be made. Over his grave was erected an obelisk of iron weighing 20 tons. In 1828 the iron coffin was removed to the Lindale Churchyard, and the monument was re-erected on a rock at the bottom of Lindale village.

Under the circumstances this monument is of great local interest, and when last year it was sold as it stands for scrap iron a local committee was formed and re-purchased it, the intention being to buy also the ground on which it stands, wall it round, and convey it and the monument to the Parish Council. It is hoped also that the first iron boat may be successfully raised from the tarn and placed beside the monument. It is estimated that a sum of £250 will be required to purchase the site, and an appeal is made to the ironmasters of this country who are interested in saving the historical relics of an industry which has done more than any other, save agriculture, for Great Britain, to subscribe to the fund. The secretary is Mr. W. B. Graham, of Broomhill, Lindale, Grange-over-Sands. Any surplus over the £250 will be devoted to raising the boat, if it can be found, from Helton Tarn and placing it in position.

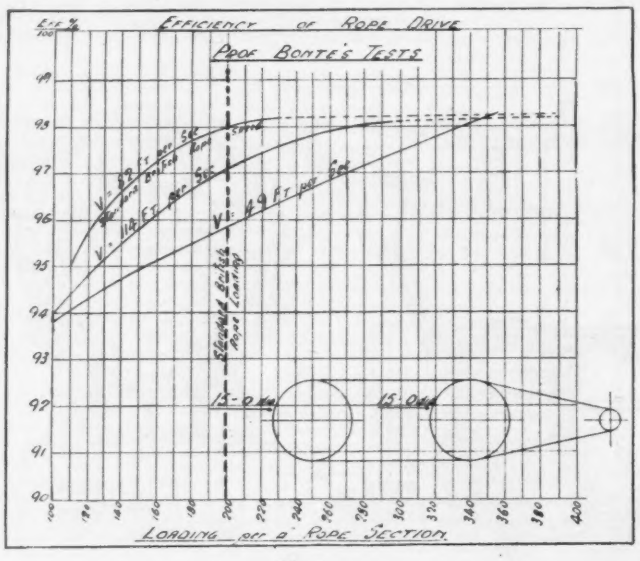



Fig. 1

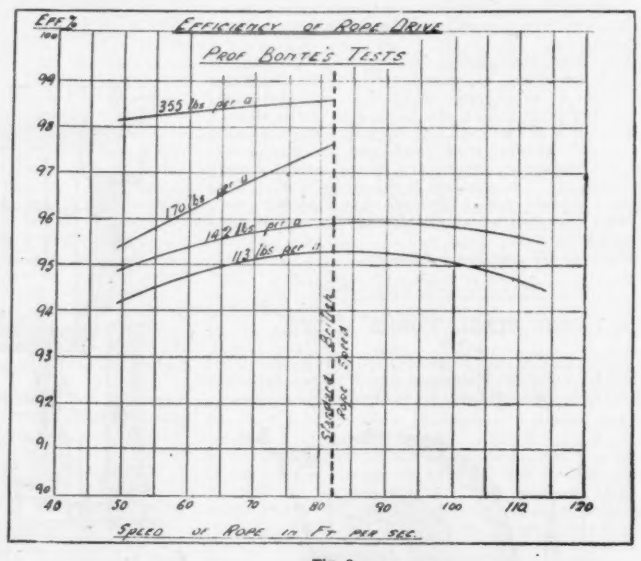



Fig. 2

SEVEN seaplanes of a novel and powerful character have been ordered by the Admiralty to be built at Cowes. It is understood they will be totally different from anything yet attempted in aerial navigation.

## RAILWAY MATTERS.

A FIREPROOF train, built almost entirely of steel, is being constructed by the North-Eastern Railway Company for service between London and Edinburgh. The train, which will be the first of its kind in the United Kingdom, has been designed by Mr. Vincent Raven, chief mechanical engineer to the company.

THE Pennsylvania Company estimates that its locomotives and passenger coaches will last twenty years, and that at the end of that period their scrap value will be 20 per cent. of the original cost. An allowance of 4 per cent. for depreciation and renewal is therefore made for locomotives and passenger stock: on freight cars it is 3 per cent. There has not yet been sufficient experience with steel cars to tell what their life will be, but for the present 4 per cent. is allowed.

A PRELIMINARY meeting of the Committee of Inquiry into the working of the Railway Employment (Prevention of Accidents) Act, 1900, was held on May 26th, for the purpose of discussing procedure, all the members being present. The Committee decided to admit the Press and public to its meetings while evidence is being taken, and the proceedings were adjourned until Tuesday, June 9th, when Lieut.-Colonel Von Donop, R.E., Chief Inspecting Officer of Railways, will give evidence.

WHEN the Transcontinental Railway which the Australian Commonwealth is now building to connect Port Augusta in South Australia with Kalgoorlie in Western Australia is completed, it will be possible to travel by rail from Rockhampton in Queensland *viâ* Brisbane, Sydney, Melbourne and Adelaide, to the western coast of the continent, a journey of about 4500 miles. The gauge of the railway is 4ft. 8½in. The gauge of the railways of Queensland is 3ft. 6in.; of New South Wales 4ft. 8½in.; and of Victoria and South Australia 5ft. 3in.

MAJOR PRINGLE has reported to the Board of Trade on the derailment of a passenger train of the North British Railway on March 14th. The accident was fortunately without fatal consequences. It appeared to have been brought about by a broken rail, but the evidence seems to indicate that the rail was not broken before the accident, and it showed no flaw or defect. Major Pringle leans to the opinion that one of the engine brake blocks got loose, and that the engine rode over it, breaking the rail, but it is clear from his report that he is not certain about the actual cause of the accident.

EXPERIMENTAL operation of the electrified Lauban–Königszelt line of the Prussian-Hessian State Railways in Silesia is now under way. On March 14th the 80,000-volt transmission from the power station at Mittelsteine to the sub-station at Niedersalzbrunn was connected up electrically for the first time. During the two weeks following the transformers, oil switches and other apparatus were "baked out" as a preliminary to the opening of service on April 1st between Niedersalzbrunn to Bad Salzbrunn. Trial trips have also been made on the section between Niedersalzbrunn and Conradsthal. The tests are being conducted with a triplet type of articulated car, the centre body of which carries a pair of pantograph collectors. In a special trial on April 7th, this triple unit hauled two steam-type trailers.

THE Baldwin Locomotive Company has recently completed for the Erie Railroad a locomotive for banking purposes which develops a tractive force of 160,000 lb. This capacity is secured by placing driving wheels under the tender, and thus making the weight of the latter available for adhesion, and, at the same time, overcoming the objection that on heavy gradients the weight of the tender detracts materially from the net hauling capacity of a locomotive of the usual type. The wheel arrangement is 2-8-8-8-2, the third group of driving wheels and the rear axle being placed under the tender. The cylinders are all of the same size, two acting as high-pressure and four as low-pressure. The two high-pressure cylinders drive the middle group of wheels. The right-hand high-pressure cylinder exhausts into the two front cylinders, and the left-hand into the two rear cylinders.

A NEW prison, about seven miles north of the Montreal court-house, is close to a tramway route, and a special car has been built for the transfer of remanded and sentenced prisoners. According to the *Railway News*, it is an old motor car, but in its new form has steel sheathing, entirely closing the sides except for a series of narrow windows just below the roof. Ventilation by means of the clerestory roof is augmented by forced draught from a heater in the front of the car. Seats are arranged as usual, except that there are two divisions, one for convicted prisoners, the other for those about to be tried. At the end of each section is a guard's seat, on a small platform. At the rear of the car is a small compartment for the use of the governor of the prison. All doors can be locked and barred. For the time being prisoners are thus conveyed to or from a point on the tramway route nearest to the prison, but a spur is being provided direct into the prison yard, and this will be used also for transporting fuel and supplies. The car has a seating capacity for fifty-four persons, and usually makes two trips a day.

A SELECT Committee of the House of Lords, presided over by Lord Barnard, had before it on Monday, May 11th, the Midland Railway Bill, which deals with a variety of matters. Mr. G. J. Talbot, K.C., for the promoters, said the only opposition was to a proposed new railway and a widening which were proposed in accordance with an obligation put upon them by Parliament when the Midland purchased the Tilbury and Southend line. The new railway was to run from Stepney, on the London and Blackwall railway, to Gas Factory Junction, or, in other words, to extend the Southend line from Bromley to Stepney. Although the new line was only 1¼ miles long, it passed through valuable property and involved a prodigious amount of disturbance. The estimated cost was £629,276. The construction would be a very long process. It would be a viaduct the whole way, and a dense population would be displaced and have to be rehoused. Several years would elapse before the line could be opened, and in order to give the relief which was sought it was proposed to widen and electrify the line from Barking to Upminster.

## NOTES AND MEMORANDA.

AN inventor in South Africa—a Mr. Esson—is reported to claim that he has devised a car which can travel at 500 miles an hour. The idea is to use a monorail and an overhead trolley wire; when the car, driven by an air propeller, attains sufficient speed, it will leave the rail and fly. The idea (but not the car), the *Electrical Review* remarks, appears to be in the air.

ORDINARY cement wash on concrete will not stand the weather. Good results can be obtained by mixing a small quantity of boiled linseed oil with the water used for the cement wash. A quart of boiled oil should be added to 10 gallons of clean water and this mixture used instead of the plain water in the ordinary way. Cement wash containing this small quantity of boiled oil will stand the weather.

WE are very glad, says the *Light Car*, to observe the growing tendency towards the fitting of mechanical starters to light cars, and we quite expect that in a few years time they will be almost in universal favour. These mechanisms must not be confused with electrical or compressed air engine starters, which operate the engine when the driver presses a button; they are far simpler than any engine starter of that nature, and as a rule consist of a device by which a rotary movement is given to the crank shaft by some more convenient means than stooping down and operating a starting handle.

IN a paper on "Repairs and Welds by Electricity," presented before the Ohio Society of Mechanical, Electrical and Steam Engineers, it was stated that a large locomotive shop operating an electrical welding apparatus, having made a careful tabulation of the total cost of the repair work, including material, time of the operator, the current and overhead charges, obtained an average cost of ¼d. per minute. The saving effected by this method is shown in the following example:—The cost of repairing forty cracks in side sheets of fire-boxes by means of the metal electrode method was £1 6s., while to renew the damaged parts would have cost about £260.

A NEW type of thermo-galvanometer was described by Mr. F. W. Jordan in a paper read recently before the Physical Society. The puff of air from an orifice in an air chamber when the air within is suddenly heated is utilised in this instrument to deflect a small suspended vane. The current to be measured is made or broken through a heater of small thermal capacity in the air chamber, and the outrush or inrush of air through the orifice delivers an impulse to the vane. The disturbing effects of extraneous heat and pulsations of external pressure are eliminated by a compensation method. In one instrument of this type the sensibility was 4 mm. per microwatt and the extremity of the throw of the vane was attained in two seconds

A PAPER on recording pyrometers, read by Mr. C. R. Darling at a meeting of the Faraday Society recently, was accompanied by a full display of the most recent types of instruments. The marked improvement which has been effected in the accuracy of these instruments was attributed by the author, and by several speakers in the subsequent discussion, to the admirable work of the National Physical Laboratory as an impartial standardising agency. Some recent advances include (1) the introduction of electric power to operate the pyrometers, either by means of relay circuits or in place of clockwork, in such a way that the automatic control of large technical furnaces may easily be provided for; (2) arrangements whereby the same instrument may be used either with a resistance thermometer or with thermal couples; (3) automatic switches with the help of which the records from several furnaces may be recorded by the same machine.

IN experiments on the determination of fatigue limits under alternating stress conditions, Mr. C. E. Stromeyer, as described in a paper communicated to the Royal Society by Professor Dalby, extended the inquiry to the measuring of the heat generated during fatigue tests. It was found that with low alternating stresses no heat was produced, or, at any rate, so little that it could not be measured, but when certain limiting stresses were exceeded, then the generation of heat was quite perceptible. The stresses, at which there was a first indication of heat production, were assumed to be the fatigue limits of the material, for the heat production suggests internal friction. This calorimetrically determined fatigue limit was practically a fixed value for any one quality of material, the most interesting case being a crank shaft from which nineteen samples were cut. In the first group of three samples cut from the end of the shaft, the minimum and maximum values of the fatigue limit were 11.15 and 11.40 tons per square inch. In the second group of eight samples cut from between the crank webs, the fatigue limits ranged from 11.30 to 11.60 tons per square inch, and in the third group of eight samples they ranged from 12.05 to 12.15.

IN the course of a paper, entitled "The Embrittling of Iron by Caustic Soda," communicated by Mr. J. H. Andrew to the members of the Faraday Society recently, it was stated that small flat specimens of wrought iron, rough filed and highly polished, were immersed in a concentrated aqueous solution of caustic soda at 100 deg. Cent. for periods lasting over several months. The specimens were examined from time to time, and it was found that the initial corrosion of the polished metal was less than that of the unpolished, but eventually both became highly crystalline, the surface of the two being similar, and their corrosion rate approximately the same. The recrystallisation of the specimens, said the author, caused them to become extremely brittle; the brittleness eventually disappeared, however, with prolonged immersion, and during the treatment with soda hydrogen gas was evolved. Experiments were carried out with the idea of showing that hydrogen diminished the rate of corrosion. An electrolytic iron was heated to 1000 deg. Cent. in hydrogen, and allowed to cool in the gas. The specimen after this treatment corroded extremely slowly, whereas another sample of the same material untreated corroded at the normal rate. It might be concluded from these experiments that the passivity of iron produced by immersion in caustic soda was due to the decrease in potential difference between the crystalline and amorphous phases, produced by occlusion of hydrogen. A 0.5 per cent. carbon steel was affected to a much less degree by caustic soda solution.

## MISCELLANEA.

THE following names have been assigned to the battleships of the 1914–15 programme:—Renown (Fairfield Company), Repulse (Palmers Company), Resistance (Devonport), Agincourt (Portsmouth).

ACCORDING to the *Manchester Guardian*, the number of electric tramcars in stock in Manchester at the end of March was 662. Of these, 351 were single cars, 266 double deckers, and 45 of the combination order. Thirty-eight car bodies are in course of construction at the department's workshops.

ON Monday, May 25th, a Committee of the House of Commons found proved the preamble of the Bill giving effect to a provisional order of the Board of Trade enabling the Cowes Harbour Commissioners to construct a breakwater on the Shrape Mud, at East Cowes, with the object of improving the harbour and affording additional shelter for yachts. The measure was opposed by the Royal Yacht Squadron and others.

THE Cefndu Transatlantic wireless station, near Carnarvon, which will be the largest transmitting station in the world, will be formally opened in a few weeks. It will communicate directly with a station close to New York. There are ten steel masts, each 400ft. high, and the last row of masts is about 1400ft. above sea level. The plant at this station will be controlled and operated from the receiving station at Towyn, Merionethshire.

SOME astonishment was caused by remarks at Hull Guildhall at the annual meeting of Hull Dispensary by Mr. James Boden, the hon. treasurer. "These exhaust gases from the beastly motor cars," he said, "produce throat diseases, eye complaints, and nasal misfortunes that will always keep our voluntary institutions going." Dr. Millburn, a motorist, and hon. treasurer of the dispensary, refuted the statement, and the Mayor, a motorist, who presided, and other motorists present took the remarks in good part.

RECENTLY the War-office issued a report by the Advisory Committee for Aeronautics as to the strength of construction desirable in aeroplanes in view of the increasing severity of conditions under which flights are undertaken. The Committee is of opinion that an attempt should be made immediately to produce machines having an increased margin of strength, and suggests that for the future no machine should be accepted for service unless the strength of the wing structure is such that the ratio of the breaking stress of any part to the stress produced in that part by a load equal to three times the weight of the machine is at least two.

IN announcing on Tuesday last that it had been decided to suspend the searching operations by flotillas and aircraft for Mr. Gustav Hamel, the Admiralty added that it desired to place on record its recognition of the services rendered to British aviation by the missing airman. "He was without question the foremost exponent in these islands of an art whose military consequence is continually increasing. His qualities of daring, skill, resource and modesty merited the respect of those who pursue the profession of arms; and his loss, if this must be accepted, is received with deep regret by the officers and men of the Naval Wing of the Royal Flying Corps."

THE Postmaster-General has addressed a letter to the Coventry Advisory Committee on Postal Matters, in which he states he proposes to introduce a system of following up calls which cannot be effected at the first attempt, with a view to making them effective. After May 31st no charge will be made for a trunk call unless the calling subscriber is actually placed in connection with the subscriber he asked for, and where a call cannot be effected at the first attempt, owing to inattention on the part of either of the subscribers or to any other cause which is apparently of temporary duration, endeavours will be made at short intervals to effect it as long as the originator desires this shall be done.

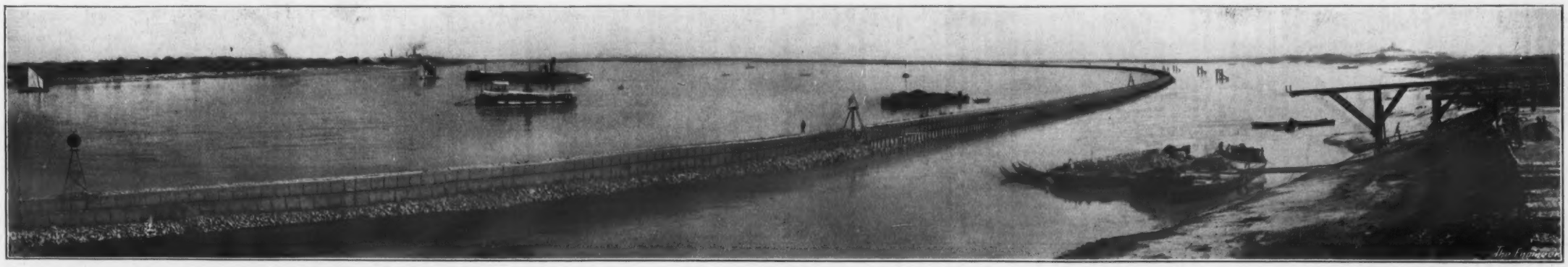
ANSWERING Mr. Wedgwood in the House of Commons recently, Mr. McKenna said that no absolute limit of temperature was fixed for cotton weaving sheds. It was the case that the French mining regulations prohibited work except in cases of absolute necessity when the temperature reached certain limits, but those limits were 95 deg. on the dry or 86 deg. on the wet bulb. There were similar regulations, he understood, in Austria and Belgium. As to fixing a limit for coal mines in this country, he could only say that the Royal Commission on Coal Mines had considered this subject, and came to the conclusion that no limit should be fixed. The limits fixed by the French law were reached in very few mines in this country.

WE learn from *Electrical Engineering* that Mr. E. E. Beadsmoore, of the Notts and Derbyshire branch of the Association of Mining Electrical Engineers, recently read an interesting paper on "Fault Testing." In it he advocated no new methods or principles, as he had obtained good results in the application of both the loop and fall of potential methods of localising faults, using suitable apparatus, but he insisted that the colliery electrician must have such instruments as a milli-ammeter and a milli-voltmeter, in addition to the usual switchboard instruments and the "megger," as he has to be able, under the regulations, to locate faults as well as to find their existence. Among the examples given of actual faults located was one in which the resistance of the fault was 43,000 ohms; a loop test was used, and in order to get enough current through the fault to obtain readings, a 500-volt megger was employed in place of a battery. The only other apparatus used in this last test was a sensitive low-resistance milli-ammeter and 25ft.—300in.—of resistance wire. This was connected between the two ends of the cable, as was also the milli-ammeter. One terminal of the megger was connected to earth and the other to a wire which was moved along the resistance wire, to find the point at which no reading could be obtained on the milli-ammeter. This was found to be between 87in. and 90in. from one end—average, 88½in.—so the test indicated the fault to be $600/300 \times 88\frac{1}{2} = 177$ yards from the corresponding end of the cable loop. Actually there were found to be two faults a few yards away from the point indicated.

# CONSTRUCTION OF THE RIVER TRAINING WALL AT RANGOON

MR. G. C. BUCHANAN, C.I.E., M. INST. C.E., ENGINEER

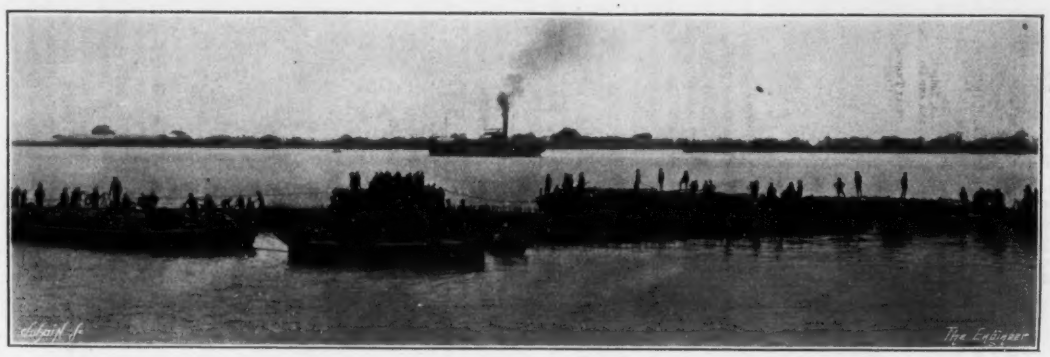
(*For description see page* 583)



VIEW OF THE COMPLETED WALL, LOOKING DOWN-STREAM

PART OF THE COMPLETED WALL, LOOKING UP-STREAM

A MATTRESS IN POSITION FOR SINKING



SINKING A MATTRESS

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# THE ENGINEER.

*MAY* 29, 1914.

### Clyde Control.

To a large section of the shipping community, which is deeply interested in the development of the Clyde, it must be a great disappointment that the expected Board of Trade inquiry into the necessity for unification of control has not been held, and is not likely to be held unless—to quote the words of the Government reply to Lord Inverclyde last week—there is a "unanimous feeling in favour of such an inquiry." It will be remembered that last year, during proceedings in connection with the promotion of a private Bill by the Greenock Harbour Trust, which was opposed by Lord Inverclyde, the matter of Clyde control was brought up by him, and on the understanding that a Government inquiry into the matter would be instituted, his opposition was withdrawn. At that time, the Clyde Trustees, the Glasgow Chamber of Commerce, the Greenock Harbour Authorities, and others, were all, more or less, favourable to the holding of such an inquiry, and there seemed no cause to doubt that a regularly instituted examination of the possibilities of the case would ensue. The approval of the Clyde Trustees was subsequently modified to the extent that Sir Thomas Mason, the chairman, wrote to Lord Inverclyde saying that while the principle was approved, the time seemed inopportune, but no specific reasons were adduced. In order to ascertain definitely the trend of feeling in the matter, the Board of Trade approached the seven different authorities on the Clyde and asked them to state in specific terms whether they were in favour of the proposition, and it now appears that the replies reveal something of a *volte-face* on the part of some of these bodies. Only one of the seven was favourable to the proposal, and that one among the least important; while three of the most influential were decidedly opposed to it; hence, unless more convincing evidence of a desire for a public inquiry is forthcoming, it is to be feared that one will not be held.

That the Government is aware of reasons for the agitation is quite apparent from official pronouncements, for last year it was admitted in the House of Lords that the navigation of the Clyde was in a somewhat confused condition, owing to the fact that no fewer than seven authorities were concerned, and it was stated that the Board of Trade would have no objections to the institution of a regular inquiry on the subject, parallel to that held not long ago in relation to the Humber. It was also mentioned that the Board was fully cognizant of the difficulties of the matter of Clyde legislation, and would be far from sorry if such an inquiry were held. In the House of Commons the Parliamentary Secretary to the Board of Trade said, "I trust, in view of the general sympathy and also of the fact that so far as my information goes, the feeling on the Clyde is substantially in favour of an inquiry, that if we can ascertain that is so an inquiry in that form will take place." It is little wonder that Lord Inverclyde, who quoted these statements in his motion for papers last week, is disappointed at the results of the formally expressed opinions of the "seven authorities," for while it might have been hoped that a modified acquiescence would have resulted, it is perhaps not surprising that these interested parties should, on further thought, have refused to do anything which would tend to end their individual existence as corporate bodies, and merge them into a common river control board. Lord Inverclyde contended that if the shipping associations and chambers of commerce had been consulted, a different answer would have been given, and Lord Granard replied, on behalf of the Government, that the Board of Trade would do anything it could to improve or help the condition of the Clyde with the greatest pleasure, and would communicate with any authorities that Lord Inverclyde might suggest. There the matter rests meantime. It would be a great pity if it ended there; indeed, it is hardly possible that it should do so, for there is hanging over the head of the Clyde Trustees the necessity of providing a dock large enough to accommodate the largest size of mercantile vessels or battleships. As we have previously stated, this dock question is inextricably bound up with the other and larger question of unification, for as the matter stands now, parliamentary powers have been obtained for such a dock, to be situated many miles up a narrow and tortuous river, further up even than the yard at Clydebank, from which the Aquitania was successfully taken to the sea a week or two ago. To those who know anything of the responsibility and anxiety attaching to river pilotage of such huge vessels, even in calm weather, such as it was the fortune of the Aquitania to experience, it is inconceivable that the risk would be willingly undertaken in the ordinary run of service, when the ship would not certainly have a less draught of water, and the weather might not be so very accommodating. It is true that the dock is not exclusively, or even perhaps to a large extent, built for the use of such large ships, but surely if a dock be made large enough to accommodate the largest ships afloat, it should be a *sine qua non* of its position that access to it be easy. All this has been under the consideration of the Clyde Trustees, and in spite of the superiority of Greenock as a site freely accessible to ships of any existing dimensions, it is intended to construct the dock in a situation that is almost inaccessible at present for a ship like the Aquitania. It need hardly be stated that she does not—in all probability—represent the limit in respect of size which even the near future may see. Fortunately, the actual work of construction is not yet commenced, and there is still time to reconsider the whole question; but it must seem to many that if there had been but one body controlling the whole river, there would also have been only one proposed situation for the dock, and that would not have been at Renfrew. We have previously remarked that the limitation to size of passenger vessels is not in difficulty of construction, nor in increasing responsibility of control, but rather in harbour and dock accommodation. When they have sea room and speed they are quite easily handled, but in limited spaces their great bulk and the expanse of side they present to a strong wind. makes them very difficult of control. We have had a very recent example of this in the breaking away of the Vaterland last week and further damage she has done this week in New York harbour. It is not long since a similar accident happened to the Imperator, and only a short time previously the Mauretania ran amok in the Mersey, doing considerable harm. In view of these facts and the further consideration that the sizes of ships will probably be even greater still before the proposed dock is ready for its first occupant, there is every reason to reconsider seriously the present proposal to build the dock up the river, where the difficulties of handling must necessarily make owners of large vessels think twice before they incur the risks involved.

It will be seen, then, that from this dock consideration alone, it would be better if there were only one controlling body for the whole river, free to choose a site for such a dock which would be most suitable in view of present-day requirements, without the necessity of consulting neighbouring and perhaps to some extent rival owners. The matter is really of more importance than this one isolated fact would indicate, for it touches nearly many of the shipping concerns which use the Clyde in ever-increasing volume, and is therefore of more than merely local interest. Any antagonism between rival bodies controlling different parts of the same navigable river must militate in the end against its proper development, and whether the scheme be required at the present time, or whether the change is desirable but the time inopportune, must be eventually judged by results, but it seems important enough to justify the inquiry which Lord Inverclyde desires, and which he would not ask for if he were not convinced of its necessity.

### Developments in Naval Gunnery.

One is likely to find more surprises in the history of naval architecture and gunnery, and in the earliest concomitant and reactive influences of the one and the other, than in most other branches of science. For one reason, the subjects belong, perhaps, to those lines of evolution that, by the researches they have entailed, have wrought a greater influence on the development of mechanical science, and with it of human civilisation, than most others; for another they are among the oldest of sciences; and finally,

their combined scope has covered an immense field. It is, however, not merely the originality of design displayed in the earliest days, nor the recurrence of detailed features of very early designs in those of later centuries so much, perhaps, as the constant recurrence of the broader phases of general design that are of greatest interest.

Although, as might be expected, the duration of these recurrent phases seems gradually to lessen with time and with the higher rate at which modern invention progresses, the general fact remains that, just as they have occurred in the past, they must still tend to occur in the future, and may affect either the size of ship or power of armament. Battleships of the present day, for example, cost between two and a-half and three million pounds apiece, and it is quite conceivable that we may be driven to accept, for common-sense reasons of finance, a policy in battleship construction which is less costly. This must not be regarded as any plea for limitations of naval strength relative to that of other countries, nor as a desire to restrict technical progress; but we cannot close our eyes to the enormous improvement in naval gunnery during the last decade, and we are prompted to ask, is not gunnery already so far ahead of the capability to resist it of almost any ship reasonably devisable as to suggest grave doubts as to the value received for the money spent on existing designs? This relative state of affairs between cost of ship and power of opposing gun is one that has only very recently become crucial, and it is now, or will shortly become, one of such moment that its probable influence is not easy to forecast. Fifty years ago it is very doubtful if the gun could have sunk the ship, except after very prolonged battering; twenty-five years ago a fight between European Navies would probably have demonstrated an abnormal difficulty in hitting the target except at short range; but the effect would have been much greater. Ten years ago, off Port Arthur and Tshushima, the percentage accuracy of fire was but a fraction of what it is to-day. Before long, if such a condition does not already exist, it may be almost instantaneously fatal to get within range. The development of gunnery is mainly directed towards greater accuracy and to the constant effort to carry heavier shell into an opponent's vessel at ever-increasing ranges, rather than to efforts to increase rapidity of fire, although it must not be thought for a moment that frequent improvements in the mechanical details of gun and mounting are not being introduced. It is, however, in the two broad directions indicated that influences are at work which will compel development in ship design. The flatter trajectories and great ranges obtainable by the improvement in the gun and the propellant have been enormously enhanced by the constant improvement in range finders, the size and accuracy of which is now, in some cases, nearly ten times as great as in the time of the Japanese war. At that period range-finder accuracy was such that distances could be measured to about 5 yards in one thousand or, say, 25 yards at the battle range of 5000, which was frequently employed. The danger zone—that is, the plus or minus distance on the range—of the 40-calibre 12in. weapons in use at the period was about 153 yards for a target 30ft. high, or, say, six times the limit of error of the range finder. At 8000 yards the danger zone fell to 70 yards and the error might be increased to 40, or more than half the danger zone. Obviously, wherever possible, the object is to get the range in the centre of this zone in order to enable a hit to be made in spite of error in range on either side. By the time the vessels of the "St. Vincent" class were in commission the 12in. gun had grown to a length of 50 calibres and the percentage length of the danger zone to the range compared with the 40-calibre weapon had grown from 3.06 and 0.87 per cent. respectively at 5000 and 8000 yards to 5.4 and 1.59 per cent., or nearly double for the same height of target. At 10,000 yards the danger zone of this gun is 90 yards, and a naval range finder recently supplied by Messrs. Barr and Stroud, which has a base length of 33ft., is, so it is claimed after a careful series of tests, capable of measuring to within 25 yards of 10,000 under average weather conditions. In other words, the margin of error may be nearly four times this and yet a hit will be secured. The fact that the danger zone of the 15in. gun of 45 calibre is less than that of the 12in. 50-calibre rather inclines us to believe that an increase in the length of the larger weapon will be made at no distant date. Compared with the 12in. gun, the percentages of danger zone to range at 5000, 8000, and 10,000 yards respectively are 3.86, 1.275, and 0.72, against 5.4, 1.59, and 0.9. Nevertheless, the latter figures represent danger spaces so far in excess of modern range-finder error that the advantage of the larger calibre, which permits of the use of shell of nearly double the weight, is unquestionable. With an increase in length of the 15in. gun the accuracy would be improved, and the tendency again to reap the advantage of heavier shell would again become apparent.

Where these recurrent phases are to cease is difficult to forecast. Twelve thousand yards is often taken as the range of probable maximum vision, and there is no doubt that this is considerably on the high side for Northern European waters. Trajectories equivalent to danger zones of even 1½ per cent. at 12,000 yards will still fail to obviate what will then become, even if it is not already, the most difficult problem that gunnery is called upon to face—the difficulty in target hitting caused by the rate of change of range. For ships closing the gun sight range is less than the true range, and *vice versa*, while at very long distances even the time occupied by the flight of the shell is sufficient to alter the range and to an extent vastly in excess of the danger zone. It is this ever-present side of the problem of securing hits that seems likely to cause the retention of eight heavy guns for some time to come, and which therefore controls the size of ships. Even with increase of size of weapon a reduction to six does not appear likely. Broadside fire might not be seriously affected thereby, but the great defect of three centre line turrets is the impossibility of firing at more than one vessel on the bow or quarter at the same time, unless the superposition of the centre turret over the forward be deliberately accepted at the expense of the stern fire. On the whole, then, we are forced to conclude that, however desirable it may be from some points of view, there is little cause to believe that any material reduction in size is likely to be permanent. Put in a nutshell, it is the need of carrying many guns in order to secure the chance of making fateful hits in the early stages of an engagement that is one of the greatest controlling influences in modern battleship design.

### Combinations in the Steel Trade.

IT is just over two years and a-half since the system of granting rebates was introduced by a number of steel makers in the North of England and Scotland for the purpose of inducing consumers, principally of shipbuilding materials, to limit their purchases absolutely to the firms who undertook to allow the rebates. After being in operation for two years the system was abandoned by the Scottish Steel Makers' Association last November, as it was never found to work very well in Scotland, and since that time two important members are reported to have withdrawn from the association. Not only so, but cases of underselling below the association prices were discovered, and it was thought that a price contest would take place which would also involve the North of England makers. At the end of March, however, an arrangement was made between the Scottish Association and the North of England Association, giving the former a free hand in its home market. On the other hand, the latter decided to continue the rebate system in the hope of retaining consumers, although it is doubtful whether this object has been fully achieved in the face of the increasing growth of foreign competition in the home market, quite irrespective of export markets. The differences which arose in the Scottish trade are a matter for surprise when it is remembered that both the demand and prices have declined during the past nine months. Favourable periods of trade are quite able to take care of themselves, but if ever a time existed for working in harmony in the attempt to maintain uniform prices—which, after all, are subject to the levelling influence exercised by foreign rivalry—that time should be in a period of depression. At any rate, this is the idea which prevails in Germany and Belgium, and perhaps to a lesser extent in France. Belgian steel makers in particular have now become well known for cutting prices, both in the case of raw materials and finished products, and both the French and German makers find themselves compelled to follow the example, together with British firms who are also involved in the struggle. But even the Belgian makers are becoming more interested in the question of combination for arresting any further fall in prices, especially for bars, and the Teutonic firms have also again taken up the question in general in view of the unfavourable situation of the iron and steel trades.

The position of affairs in Germany at the present moment is of special interest to British iron and steel makers. As the whole of the marketable production of pig iron in that country is under the control of the Essen Pig Iron Syndicate until 1917, no occasion exists to refer further to this particular branch, or to the semi-finished steel department, although prices are now nearly 10s. per ton less f.o.b. Antwerp than was stated a few years ago to be the actual cost of manufacture in Germany and the United States. It is, however, to certain of the finished branches that attention should be directed. When the Steel Syndicate was renewed two years ago this month the combination was shorn of one-half of its power, and was left with the control of the output and prices of only semi-finished steel, railway material, and shapes. Various constituents of the syndicate, who had developed or were in course of developing their productive capacity by the installation of additional plant on a large scale or the erection of entirely new works of huge magnitude at Hagendingen and Esch, declined to have their freedom of activity curtailed by any further restrictions in the output, and the consequence was that the syndicate lost the control of the production of bars, plates and sheets, wire rods, tubes and castings and forgings, although the prices of these manufactures had never been regulated by the combination. Excepting wire rods and shipbuilding materials, for which subsidiary syndicates have been in operation, the inland and export trades in these groups have been practically free since the prolongation of the Steel Syndicate, as the gas and boiler tube combination collapsed some time ago. During the period of the last boom the situation was very satisfactory to the steel makers, but with the change which commenced nearly a year ago, combined with the gradual bringing into service of the new plant and works, the position has become entirely altered and inland prices are now about 30s. per ton less than a year ago. The Shipbuilding Steel Syndicate is no longer effective owing to the competition of new producers, who are determined to make a market for themselves, and a similar observation also applies to bars, tubes, and wire rods, although the Wire Rod Syndicate has just escaped dissolution by being provisionally prolonged, for the second time in one year, until the beginning of October.

The chaotic condition of the inland trade in Germany, which is solely due to the over-productive capacity of the industry, combined with the gradual fall in the export prices, has now had a surprising result, which is attributable to the inter-connection of syndicates, or rather of the constituents themselves. Apart from the ordinary coal mining members who only produce coal, coke, and briquettes, certain of the other members of the Westphalian Coal Syndicate who also manufacture iron and steel have a greater interest in the continuance of the Coal Syndicate than in the formation of syndicates for bars, plates, tubes, &c. Negotiations are proceeding for the renewal of the Coal Syndicate, which will nominally expire at the end of 1915; but the representative of one of the works' collieries—the Rhenish Steel Works—recently declared that unless syndicates were also constituted for the manufactures in question simultaneously with the prolongation of the Coal Syndicate until 1921, and for the same period of years, his company would decline to sign the Coal Syndicate agreement, but would take up the question of competing all along the line in iron and steel products, in which the company's interest is greater than in an extension of the Coal Syndicate. As a definite withdrawal from the latter would cause the Coal Syndicate to collapse, apart from other questions which also offer difficulties in the way of a renewal, the threat has had the remarkable effect of attracting the attention of the constituents of the Pig Iron Syndicate and the Steel Syndicate, the latter of which at once convened a special meeting to consider the new situation, when representatives of certain open-hearth steel works which are still outside the syndicate were also present. It seems that a general disposition now exists favourably to consider the proposal made on behalf of the Rhenish Steel Works, as separate committees have been appointed by the Steel Syndicate to consider the question of syndicating bars, plates and sheets, tubes and castings and forgings, whilst wire rods are being left for the Rod Syndicate itself to deal with for the present. Although it would be unwise to attempt definitely to predict the probable outcome of the deliberations which are already in active progress, it would appear doubtful whether the desired result will be accomplished owing to the confliction of interests as between the large and the smaller works, the enormous difficulty of coming to agreements with regard to the tonnage allotments or the respective shares in the branches concerned, the failures to syndicate bars and tubes in the past year or two, and the proposed construction of further tube mills by certain works. But if, contrary to expectation, the scheme should be realised, it would imply higher inland prices and greater financial strength for forcing the export trade, which even in the present year has already made an advance of 23,000 tons as compared with the first quarter in 1913.

## OBITUARY.

### SIR JOSEPH WILSON SWAN.

WE much regret to have to record the death of Sir Joseph Wilson Swan, which took place at his home, Overhill, Warlingham, Surrey, on Wednesday last. Sir Joseph was born on October 31st, 1828, and he was therefore in his eighty-sixth year at the time of his death. His native place was Sunderland, and on both his father's and mother's sides he came of families gifted—possibly beyond the ordinary—with mechanical and inventive abilities. Sir Joseph cannot himself be said to have been an engineer. He was rather a chemist and a physicist, yet his work and discoveries have had immense effect on the world of engineering.

Like most small boys, young Swan early developed an interest in chemistry; but, unlike most boys, he was destined to become distinguished in this branch of science. His father, who must have been a man of considerable discernment, decided that his son should take up professionally the study for which he had shown predilection. Accordingly the boy, after but a meagre schooling—as was indeed the custom in those early times—was apprenticed to a firm of chemists in Sunderland. Later on he entered the service of Mr. John Mawson, a distinguished chemist of Newcastle-on-Tyne, and later still, in 1860, became his partner. This association had important results, the energy and ability of the young man quickly adding an impetus to an already flourishing commercial undertaking. The inventions attributable to Swan during his active connection with the firm of Mawson and Swan were many and various and were chiefly connected with photography. He it was who worked out the carbon process, the developments of which have had such an important bearing on modern photographic reproduction methods. He also achieved great distinction by his discovery of methods for increasing the rapidity of photographic dry plates.

Great, however, as was his reputation as an inventor of things chemical and photographic, it is certainly in connection with the introduction of the incandescent electric lamp that his name is, and will be, most generally associated. It is not our purpose here to enter into a discussion as to who was the real and true original inventor of the electric glow lamp. All that we need say here is that Swan was the first in this country, at any rate, to render a system of lighting by incandescent electric lamps commercially possible. The first public exhibition of the Swan glow lamp was made at a lecture given by Mr. Swan in Newcastle in 1879, and the new method of lighting, coming as it did at a time of rapid development in the means of producing electric currents, developed at a very rapid rate. Two years later, in 1881, so great an impression did an exhibit of these lamps make at the International Exhibition at Paris that Swan was created a Chevalier de la Légion d'Honneur. It would be impossible to give in detail a list of Swan's other inventions, but mention should just be made of an important improvement in storage batteries, in which the cellular principle was applied to plates.

Sir Joseph was the recipient of many distinctions, though most of them were a good deal more tardily bestowed than had been that of the Légion d'Honneur. It was not until 1894 that he was made a Fellow of the Royal Society, and not till 1904 that he was knighted in recognition of his services to science. It was only this year that a movement to confer on him the freedom of Newcastle-on-Tyne was set on foot, and this had not reached a definite conclusion at the time of his death. He was president of the Institution of Electrical Engineers in 1898–9 and was subsequently made an honorary member of that body. He was also an honorary member of the Royal Photographic Society and of the Pharmaceutical Society of Great Britain; president of the Literary and Philosophical Society of Newcastle-on-Tyne; corresponding member of the Royal Philosophical Society of Glasgow; past-president of the Society of Chemical Industry, and first president of the Faraday Society; vice-president of the Senate of University College, London, from 1899 to 1903, and life governor of that college. To him were also awarded the Hughes Medal of the Royal Society—1904—for his work in connection with the incandescent lamp and other applications of electricity; the Albert Medal of the Society of Arts—1905—the Progress Medal of the Royal Photographic Society; and the Gold Medal of the Society of Chemical Industry—1903. He was also granted the honorary degrees of Master of Arts and Doctor of Science by the University of Durham. He was a member of the Royal Commission of 1903 to watch over British interests at the St. Louis Exhibition.

## LITERATURE.

*British Factory Administration and Accounts.* By Edward T. Elbourne. London: Longmans, Green and Co. Price 25s. net.

ON the subject of workshop management and administration, a multitude of books has been published within the last few years. By far the greater number of these have had their origin in the United States, for it is a subject on which our friends on the other side of the Atlantic are prolific in ideas. Even if the methods indicated in these books were, of themselves, free from objection, the volumes would still be of very little use to engineers in this country. For the conditions—physical and social—that prevail in America are quite incomparable with those in Great Britain.

By the publication of Mr. Elbourne's work on "Factory Administration and Accounts," any defect in the literature of this subject from which we in this country may have suffered is made good. That the book is English in its sentiments may be gathered from the fact that its author was formerly works accountant to Vickers, Sons and Maxim, Limited, at Erith, and departmental manager to the Birmingham Small Arms Company. He has been assisted by Mr. Andrew Home-Morton, of Messrs. Home-Morton, Ker and Gibson, the well-known firm of consulting engineers and industrial works designers, and by Mr. John Maughfling, the secretary to John I. Thornycroft and Co., Limited. Signs are not wanting that the American influence has been at work here and there, but when we take the book and the methods it recommends as a whole, we cannot say that it does any great violence to accepted ideas of works management prevalent in this country.

The book is divided into six sections. The first is contributed by Mr. Home-Morton, and discusses the problems associated with the design and lay-out of industrial works and factories. It is a fairly short section, treats the subject in a very general way, concentrates attention on the construction of new works, and dismisses the, in this country, far more important subject of the reconstruction of existing works, in sixty lines. The second section deals with "General Administration." It covers such matters as the organisation of the staff, the organisation of the routine to be observed by the staff in the exercise of its daily duties, correspondence and estimates. The third section is headed "Works Administration." In it are discussed questions relating to the management and control of the workers, the purchase, inspection, storage and identification of the raw material and the dispatch of the finished products. A portion of this section is devoted to the subject of "Production Efficiency." Here no attempt is made to demonstrate that there are any golden rules for achieving production efficiency. It is recognised that each case has to be treated according to its limitations, and that local circumstances and traditions exercise a vital influence on all questions relating to the efficiency of the worker. "Organisation can never be a substitute for good men," says the author, and here, in a line, we have, we believe, the whole case against "scientific management" and its brutalising adjunct, "motion study."

In the fourth section, "Works Accounts" are considered. It is the theme of the book that works management should not be regarded as a subject wholly apart from all questions of works accounts, that the cost of producing and delivering the goods sold is as much the business of the works manager as the methods employed in the production of the goods. We accordingly find 160 pages or so given up to accounting matters. The methods to be observed in estimating and drawing up statements of cost allocation accounts, shop charges, stocktaking, stock accounts, &c., are fully set forth. The fifth section is designated "Routine Forms," and gives examples with notes of suggested printed forms suitable for adoption in the works and offices in connection with the methods outlined in the preceding sections. These routine forms are very complete. There are some 145 of them, and we cannot help thinking that were they all adopted in any one works the annual expenditure on stationery would be considerably more than the money saved by their use. The sixth section of the book is contributed by Mr. Maughfling, and deals with financial accounts—that is to say, with such work as falls to the secretary of a limited liability engineering company.

From this brief outline it will be seen that the book covers an extremely wide field—a wider field than that of any other similar work which we have come across recently. Its highest value will, we believe, lie in assisting those who are contemplating the re-organisation of their works. Here it should be of immense service in teaching what has been already proven to be good and what bad. In studying it, however, it should be remembered that over-organisation is as undesirable as no organisation at all. The book should, therefore, be read with discretion, and with a proper appreciation of the fact that it designedly represents no one set of conditions.

We have only one serious criticism to offer. On page 50 Mr. Elbourne, in discussing the subject of "Publicity and Sales Promotion," writes as follows:—"It may be remarked here that an important value of all advertisements is in the right it gives to press notices in the body of the paper." Whatever may be the custom of other journals in this matter—and we are fain to believe that no reputable periodical is guilty of such a practice—our readers may rest assured that the editorial space of THE ENGINEER cannot be bought for any consideration whatever.

## SHORT NOTICES.

*Gold Dredging.* By T. C. Earl. Pages 8¾in. by 5¼in., xv. and 208; also 78 illustrations and 17 maps. E. and F. N. Spon, Limited. Cloth. 20s.—This is quite an attractive looking little volume, well printed and profusely illustrated, on surfaced paper—but what of it all? Of the total space allotted to matter, equal to 208 pages, the equivalent of 98 pages is devoted to illustrations or blankness; and of the illustrations, many of the maps, although diagrammatic, are useful; some of the reproductions, too, are distinctly interesting, but the rest, while good, are just similar to those in manufacturers' catalogues before us. The latter, however, have the advantage of those in the book in that many of them are described, whereas beyond the foot-lines we have found neither description nor even direct reference in the text to illustrations in the book. We have been equally unsuccessful in our search for a good and complete descriptive account of any dredging plant or any dredging enterprise in operation. True, Chapter X. contains a sort of catalogue of parts and some particulars, whilst in Chapters XII. and XIII. there is a cursory account of the erection of a dredge in the former and of its working in the latter, the whole space covered by the letterpress in these cases being that of five pages. There are several illustrations interspersed, and so the number of pages seems more; but no reference is made to these illustrations, and, moreover, they have no special reference to the matter in the text of these two chapters. The text in general seems to consist mainly of inconsequent scraps, including some quite useful hints, but many mere platitudes or remarks of very little or no merit.

*Technical Mechanics.* By E. R. Maurer. New York: John Wiley and Sons. London: Chapman and Hall, Limited. Price 10s. 6d. net.—The scope of this book is neither theoretical mechanics nor applied mechanics, but something in between. It may be described as pure mechanics, specially expounded for the benefit of engineers. The title seems original, and the treatment certainly is. Although it includes all the usual subjects, the book is not superfluous or redundant with others of its class. The author has an extremely clear and original way of expressing himself, and even when he is discussing some hackneyed subject, such, for example, as the laws of motion, he succeeds in imparting fresh ideas to his readers. Although it is an American production, we have every confidence in recommending it to students in this country. This is the third edition, and has been rewritten.

*Engineers' Costs and Economical Workshop Production.* By D. Smith and P. C. N. Pickworth. Manchester: Emmott and Co., Limited. Price 4s. 6d. net.—This volume can be commended to all interested in efficient workshop management and to those desiring to become acquainted with the financial and business aspects of an engineering undertaking. It deals in the first place with such subjects as the cost of raw materials, wages systems, shop organisation and establishment charges, estimating and the despatch of goods by rail and water. At the same time, it covers incidentally many subjects not of a strictly financial aspect. For instance, it deals with the shape of cutting tools and the best speeds and feeds for them, it discusses the various classes of fits, and it tabulates certain test requirements for the commoner engineering materials.

*Mechanics and Heat.* By W. B. Anderson. London and New York: The McGraw-Hill Book Company. Price 8s. 4d. net.—This is a school or college text-book. The author makes no excuse for its publication, although he indicates that a claim to attention may be found in his endeavour to treat his subject in a practical manner and with its practical applications directly in view. The book seems to be intended for two classes of students, namely, engineering and agricultural. The latter class is specially catered for in the section devoted to heat, and particularly in the chapter devoted to meteorology. The information is nearly everywhere of a somewhat scrappy nature, and the chief characteristic of the volume is the number of subjects dealt with in its comparatively small compass.

*Formulaire du Candidat-Ingenieur.* Par Maurice Percheron. Paris: H. Dunod et E. Pinat.—This is a neat little vest pocket book containing a collection of formulæ and tabular information relating to mathematics, mechanics, physics, and chemistry, and should be extremely useful as a source of reference for students of these subjects and those who have to make use of such matters in their daily business. The fact that it is in French need make scarcely any difference even to one totally ignorant of that language.

*The Principles of Automatic Telephony.* By Walter Atkins. London: The *Electrician* Printing and Publishing Company, Limited. Price 2s. net.—This little book has been given a very general title. In reality, it describes only two systems of automatic telephony, the Lorimer and the Strowger. Although it is not a "popular" work, anyone with an elementary knowledge of ordinary manual telephony will be able to follow it. It should serve as an excellent introduction to the subject.

*Hydraulics.* By E. H. Sprague. London: Scott, Greenwood and Son. Price 3s. 6d. net.—This little volume should be appreciated by students, draughtsmen and others engaged on the subject of hydraulics or the design of hydraulic machinery. It treats the matter in the orthodox way, but the conciseness with which the information is presented and the numerous worked examples should attract many readers. It is moderately mathematical.

## BOOKS RECEIVED.

*The Steel Foundry.* By John Howe Hall. London: The Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 12s. 6d. net.

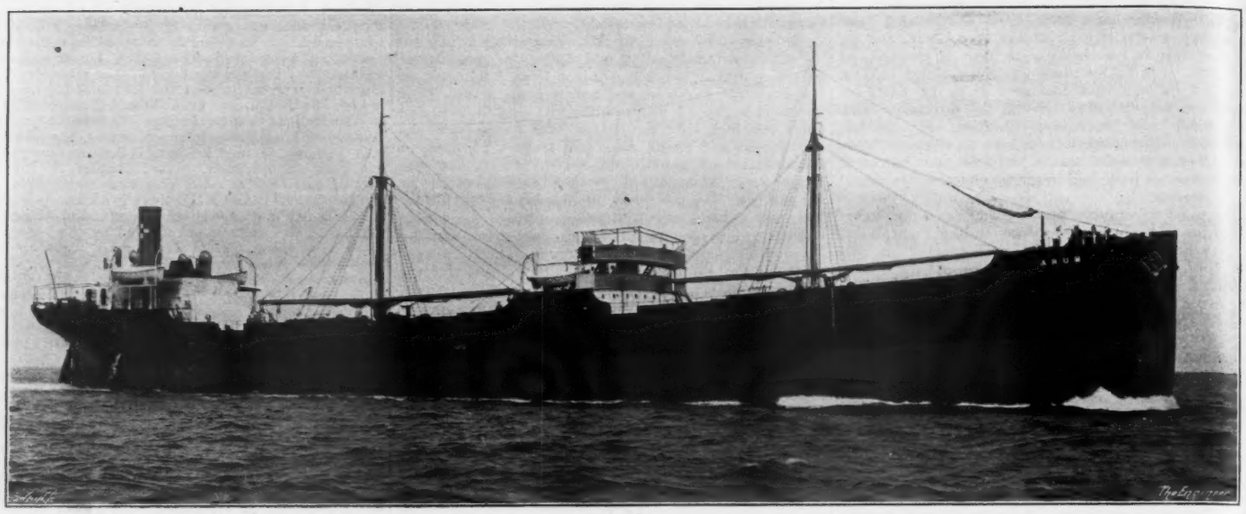
*Steam Pipes: Their Construction and Arrangement.* Manchester: The Vulcan Boiler and General Insurance Company, Limited. Price 1s. net.

*The Year-book of Wireless Telegraphy and Telephony, 1914.* London: The Marconi Press Agency, Limited, Marconi House, W.C. Price 2s. 6d. net.

*Telegraphy.* By the late Sir William H. Preece, F.R.S., and Sir J. Sivewright. New edition. London: Longmans, Green and Co., 39, Paternoster-row. Price 7s. 6d. net.

# MOTOR SHIP ARUM

SWAN, HUNTER, AND WIGHAM RICHARDSON, LIMITED, WALLSEND-ON-TYNE, BUILDERS AND ENGINEERS



## THE MOTOR SHIP ARUM.

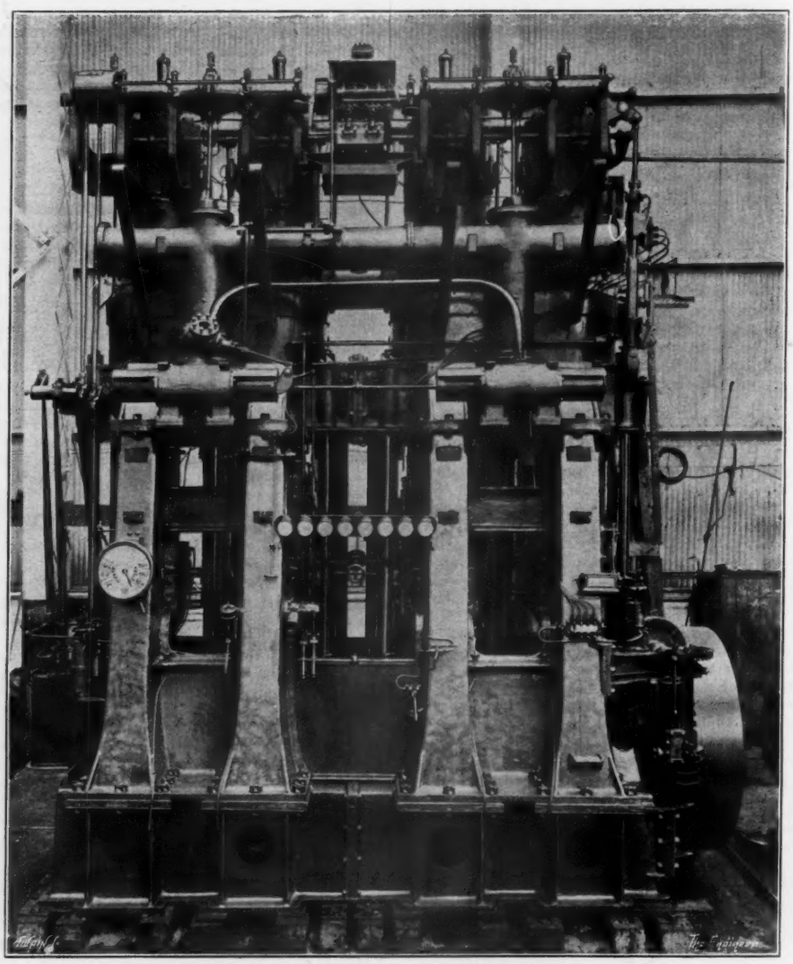
IN our issue of December 5th, 1913, we gave a brief account of the launch of the motor ship Arum, while in that of March 6th, 1914, we described a set of Polar Diesel two-cycle engines which are of the same general design as those fitted on that vessel. It will be obvious, then, that there is not a very great deal to say in the present article, though, however fully the ground was covered in the two articles mentioned, it is impossible to dismiss the Arum in a few lines, seeing that her engines present an English marine engineering firm's interpretation of a continental Diesel engine builder's design. The six-cylinder Polar Diesel engines of the Sebastian, which formed the subject of our article of March 6th referred to above, were built by the Diesels Motorer A.B., of Stockholm; those of the Arum are four-cylinder Polar Diesel engines, built by Swan, Hunter and Wigham Richardson, Limited, under licence from the Diesels Motorer A.B., so that the main outlines, such as port scavenging, the use of the scavenge cylinders for starting up, &c., are provided by the Swedish firm, while the details connected with the carrying out of that design have been worked out by the British firm. It will not be necessary to dwell upon those points in which the two engines resemble each other, but it will certainly be of interest to point out fully the differences which are to be noted between the two designs.

Entering the engine-room, the same simplicity of the tops is to be seen as in the Sebastian, the rocker for the fuel valve being the only moving part visible beyond, of course, the cam shaft. The rocker and its connections are a fine substantial job, and these engines show the best attempt that we have yet seen to enclose completely the cams and rollers; a light cast iron casing is fitted right over the top of the shaft, and there is only a narrow slot in the lower part of the trough for the rocker to work in, and this trough forms an oil bath in which the roller runs. This, with the fewness of parts, leads to a very quiet valve gear.

The method of driving the cam shaft differs from that of the Sebastian, but the change is hardly to be put down to the trend of English marine engineering design. Here the shaft is driven by a pair of what we prefer to call coupling rods A A—p. 599—from excentrics carried on a disc on the forward coupling of the crank shaft; this arrangement was first introduced, we believe, by the Nederlandsche Fabriek on the Vulcanus, and was followed by Messrs. Burmeister and Wain in the Selandia and her sisters. The engines of the Arum, owing to the scavenge cylinders being placed below the main cylinders, are of unusual height, so that these coupling rods, if made in a single piece, would be of excessive length, and they are therefore made in two parts, which are connected together by rocker arms B in the centre; consequently they are quite rigid at a speed of 120 revolutions per minute, which was the highest speed at which we saw the engines running. The arrangement is very neat, and we cannot help liking it, in spite of the fact that it has been given up in the latest Burmeister and Wain engines, we believe, because it has been found to be not absolutely "fool-proof."

The arrangement for reversing is the same as on the Sebastian, except that the whole cam shaft slides fore and aft, instead of only the fuel cams sliding on the shaft, and the same inclined planes are provided to allow the roller to travel from the ahead cam to the astern cam; in the Arum, too, a bell crank C at the end of the shaft is used to give the fore-and-aft motion through a link connection to the reversing wheel on the starting platform. Here, too, is another point of difference from the Sebastian. In that ship the scavenge valves for each pair of cylinders were operated by a pair of excentric rods on a special little shaft of their own, while in the Arum a single excentric on the cam shaft is used, which drives the valve D—p. 599—for both cylinders through the rod E and guide F. The beauty of this arrangement is that not only is the need for the special little shaft and the two excentrics obviated, but the excentric itself is also reversed through 180 deg. to give the proper opening to the scavenge valve by means of the sliding motion of the cam shaft. The means adopted for reversing this excentric are really practically the same as those so commonly used on two-cycle engines for rotating the cam shaft in relation to the crank shaft—that is, a thread G on the shaft is pushed through the nut H which carries the excentric, which is thus rotated—see p. 600. It makes a simple reversing gear. Then, instead of having a separate lever to be operated by hand in case of necessity only, a short arm K is fitted at the bottom of the bell crank which pushes the cam shaft along, and this arm K carries a roller on it, so placed that whenever the shaft is in what we may call "mid gear" the roller depresses an arm on the shaft L, which passes right along the engine, and thus, for every manœuvre, opens the relief valves M of all the cylinders and so relieves the compression and allows the use of very low pressure air to start the engine. The simplification suggested in our notes on the Sebastian had evidently been forestalled, and a single valve acts both as relief valve and compression release valve.

The manœuvring valves have been simplified from the original design and are carried in the horizontal casing N. They are moved into the correct position to act as suction and discharge valves for the scavenge pumps when the engine is running, or inlet and exhaust valves for the air when starting by means of the rod R operated by a lever on the starting platform. The starting air or atmospheric air are admitted or shut off as required by the valve P operated from the same source. An appreciable simplification is seen in the casting of the manœuvring valve



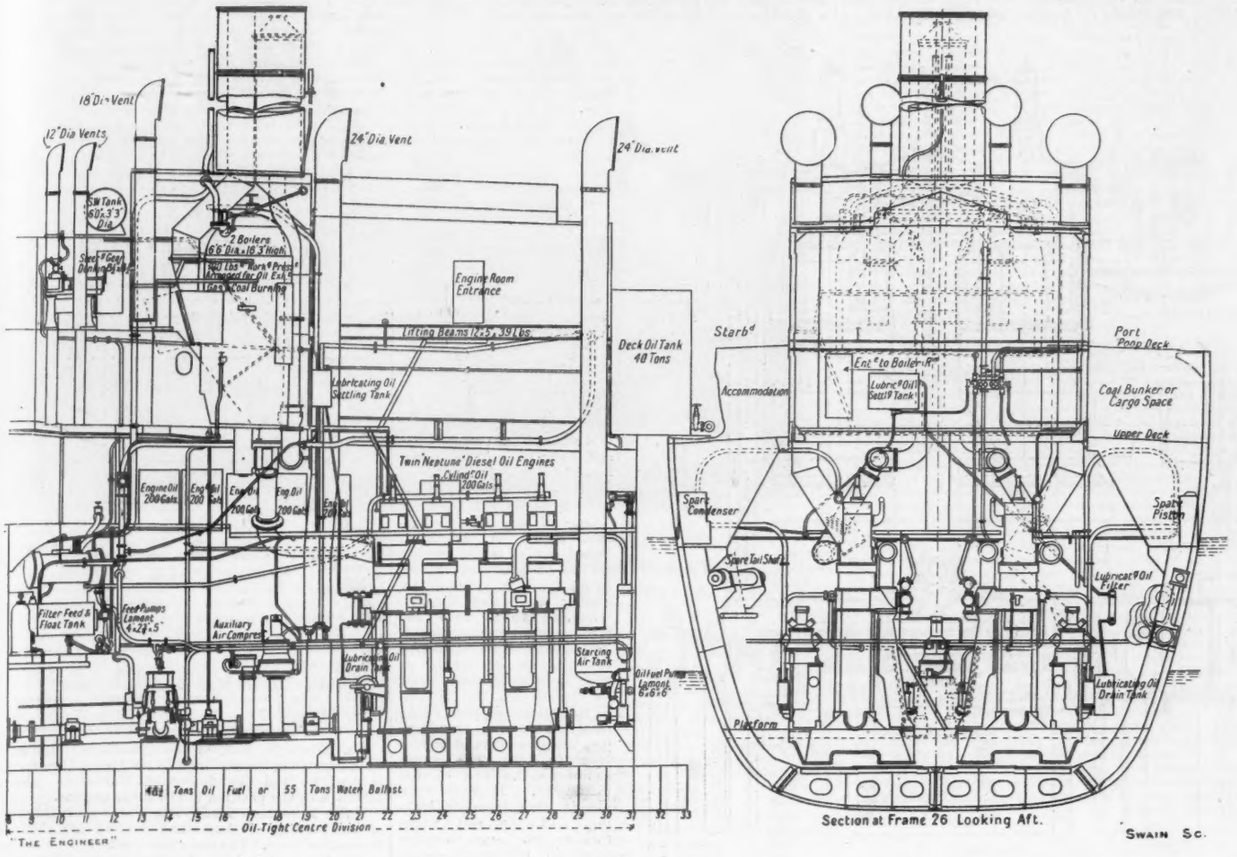
STARBOARD ENGINES OF THE ARUM

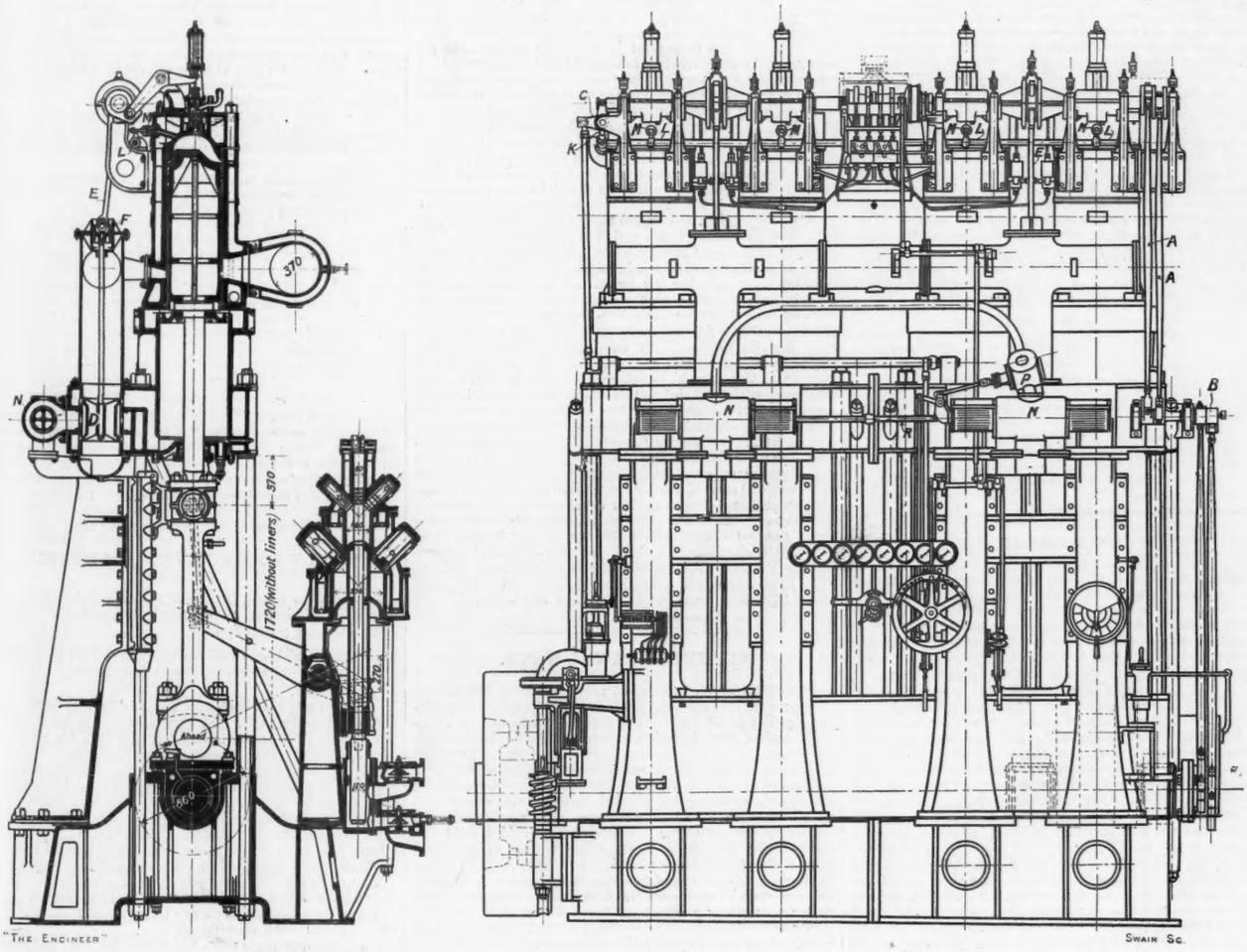
chamber and in the operating parts.

As the drawings show, the details of the cylinder construction are much as on the Sebastian, the jacket and liner being cast as one piece, with the scavenge cylinder attached to its underside. As with the Sebastian, this entails, in order to get the piston out, the removal of the cylinder cover and the bottom cover of the scavenge cylinder so as to reach the nuts which attach the piston to its rod; the bottom cover is, however, very much more accessible

# ENGINE-ROOM ARRANGEMENT AND ENGINES OF THE ARUM

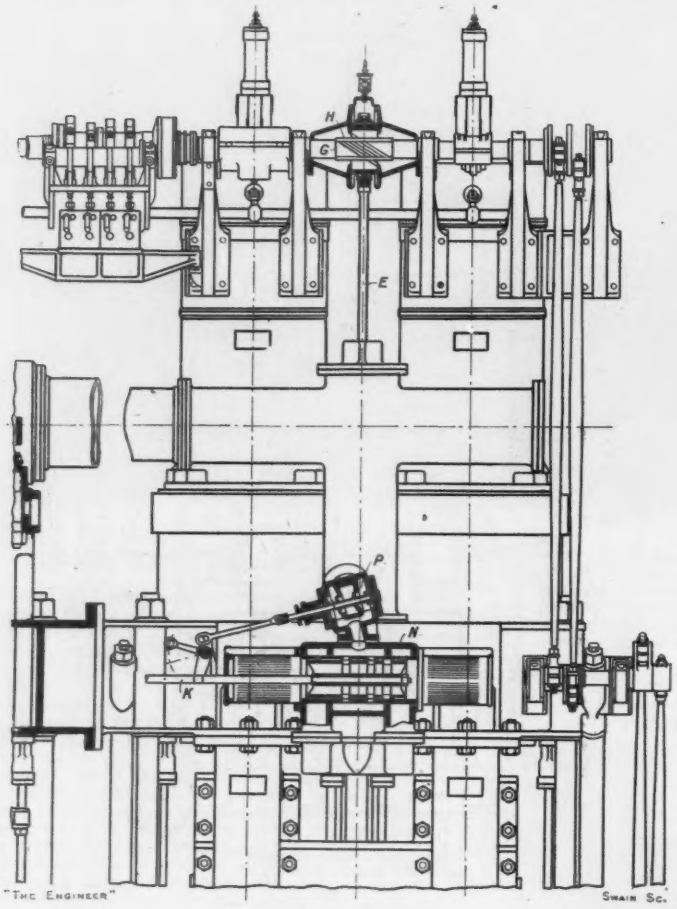
(For description see opposite page)



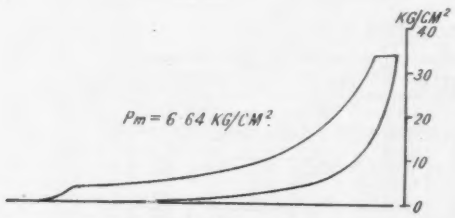
than in the Sebastian, the nuts being on a flat surface which is below the bottom of the scavenge cylinders and not recessed up into a dark inaccessible hole. The piston, too, is of different design, and is of considerably greater length, and we should assume also of considerably greater weight.

It is below the cylinders that we come to the most noticeable differences in design. Forced lubrication is




DETAILS OF VALVE GEAR

not employed, and its omission allows the engine to be much more open, as will be seen, the turned steel columns reaching right up to the bottom of the cylinder and all being open below that; thus the guides and crosshead pins are very much more accessible for feeling when running or for overhaul and, moreover, they are not blocked, as in the case of the Sebastian, by the air compressors, which with their rockers are, in that ship, carried on the framing. In the Arum there is a compressor of the three-stage type for each pair of cylinders, but they are supported on cast iron columns thrown up from the bed-plate with turned steel columns in front and driven by good sturdy rockers. The strength and solidity of this part of the engine is one of the most attractive features of the design, and when running at 120 revolutions per minute there appeared to be hardly a tremor on the top of the compressors, whereas we specially remarked that the support from the columns in the Sebastian seemed to be hardly stiff enough. The niceness of the design is further enhanced by carrying the plunger of the compressor down below




POWER DIAGRAM

the rockers to form, in the case of the forward set, a bilge pump and in the after set a circulating water pump.

There is one important feature of the design which affords much food for discussion; it is the method of supporting the cylinders. The back of the engine is carried on turned steel columns in the ordinary way, and these columns take both the tensile and compressive stresses; the front of the engine is carried on cast iron columns of the ordinary marine engine type, but there are in addition two turned steel columns of smaller diameter than those at the back. We understand that the nuts on these columns are screwed down so as to put the cast iron columns in compression, and so relieve them entirely of any tensile stresses. There are no shoulders on the front steel columns, and they can thus only take the tensile stresses. If the guides had been bolted to the front columns, and if these front columns had the shoulder and had been made of the same diameter as the back columns, they could have taken the place of the cast columns altogether and have taken both the tensile and compressive stresses, but they would not then have afforded the necessary lateral stiffness, as they must, of course, be kept as near the centre of the crank shaft as possible in order to relieve the bed-plate of bending stresses. It would then have been necessary to fit another set of diagonal steel columns opposite to the existing one in order to afford the lateral stiffness in both directions. There is then, on the one hand, one cast iron column per cylinder in compression and two light steel columns in tension, while, on the other hand, there would be the two larger diameter steel columns with the necessary flats to take the guides, but with positive adjustment to a shoulder and the additional diagonal stay. We must admit we feel ourselves unable to say which is the better arrangement from the point of view of strength, stability, and cost combined. The case is worth stating, as the Nederlandsche Fabriek has a similar design, but it makes a positive adjustment on the front steel columns and leaves a clearance that can be felt when the engines are running, between the top of the cast iron column and the cylinder, so that the cast iron column only has to carry the guide and serve as a lateral stiffener by means of side plates on the flanges. Though the cylinders of the two ships are of approximately the same diameter, the stroke of the Arum is considerably greater than that of the Sebastian, and this makes the connecting-rod of the former look much less "tubby," though the proportion of length to stroke is the same in each case.

One of the most important points in the large Diesel engine is the cooling of the piston, and in the Arum this is effected by forcing sea water through telescopic tubes into the bottom of the piston-rod. The arrangement is carried out perhaps as nicely as such an arrangement could be carried out, the bottom of the telescopic part being attached to the crosshead pin, with a nice solid copper pipe to take the water round to the end of the piston-rod. Most of the glands were, however, leaking, and the salt water makes an objectionable mess in the engine-room. If fresh water were used, which we cannot help thinking is desirable, leakage would also entail expense in "make-up" through an evaporating plant. The glands in question can be adjusted while under way, but it is not the easiest of jobs at 120 revolutions per minute. We imagine that, in cases of real emergency, they could even be re-packed while under way, but we should prefer not to have to tackle the work ourselves. Of course, with an open engine and no forced lubrication the chief objection to moderate leakage is the mess, though if it becomes serious the pumps might be unable to supply the pistons and it would lead to rust in important parts as well. We have not yet seen a better arrangement than that of the "walking" pipes as fitted on the Eavestone.

The exhaust is led into big water jacketed pipes at the back of the engine, but where two of these lengths of pipe join there is a short space which is not jacketed, and the exhaust at this spot is quite noisy, obviously due to resonance in a comparatively thin pipe. The water jacketed part only extends for the length of the engine and the pipe is then lagged. At the end of the engine-room the exhaust can either be passed up the funnel or under the donkey boiler. All the auxiliaries are steam driven, and they include an auxiliary compressor, electric lighting engine, turning engine, pumps, &c. On the occasion of our run off the Tyne the engines worked well, starting and reversing with certainty, but there was a considerable amount of vibration about the engine itself, though on deck it was practically unnoticeable. The noise, too, was somewhat more than we expected to find, though a considerable part of it was due to the resonance of the exhaust pipe already referred to. Each set of engines has four cylinders 410 mm. diameter by 860 mm. stroke, and gives 675 brake horse-power at 123 revolutions per minute.

We may remind our readers that the Arum is a twin-screw general cargo ship built by Swan, Hunter and Wigham Richardson, Limited, for Sir Marcus Samuel, for the Persian Gulf trade. She is 360ft. long overall, 47ft. beam, and 27ft. moulded depth, and will carry about 5000 tons dead-weight at about 10½ knots.

## OIL FUEL FOR THE NAVY.

The terms of an agreement made between the British Government and the Anglo-Persian Oil Company concerning supplies of oil fuel for the Navy are set out in a Blue-book which was issued on Monday last. Under this agreement the Government is to subscribe £2,000,000 in ordinary shares, £199,000 in debentures, and £1000 in preference shares, or a sum of £2,200,000 in all, which will make the total capital of the company in shares and debentures £4,799,000. As the existing debentures represent £600,000, the Government will just hold the preponderating interest in the share capital of the company. By an agreement, which will have to be ratified by the existing shareholders, the Government is to have two directors *ex-officio* on the board of the company with power to veto any decisions come to by the board, an assurance being given, however, that this veto will only be exercised under special circumstances.

The company has undertaken to supply oil to the Government for a term of years at a price which is not stated, but which is referred to as being favourable, and the quantity to be supplied is stated to bear a reasonable proportion to the "total estimated annual requirements of the Admiralty on the present basis of policy of oil consumption, and with due allowance for expansion." The concession owned by the oil company is in Persia, where there are several tried oil-bearing fields, and many other places in which oil is considered to exist.

Having regard to this step by our own Government, it is interesting to note that it is reported that the German Government has financed a company operating in Mesopotamia, and has come to an agreement by which supplies of oil fuel for its navy may be obtained on satisfactory terms. It is curious that the two Governments should have chosen districts of the globe so near together as Persia and Mesopotamia from which to draw a proportion of the oil fuel required by their warships.

## AUSTRALIAN NOTES.

From a return issued by the Commonwealth statistician the following items are taken of the production in Australia for the past year:—

*Commonwealth Production for the Year* 1912 (*in thousands*).

| | New South Wales. | Victoria. | Queensland. | South Australia. | West Australia. | Tasmania. | Total. |
|---|---|---|---|---|---|---|---|
| | £ | £ | £ | £ | £ | £ | £ |
| Gold | 702 | 2,063 | 1,478 | 28 | 5,448 | 161 | 9,880 |
| Coal | 3,660 | 259 | 338 | — | 136 | 25 | 4,418 |
| Silver lead | 3,756 | 2 | 122 | — | 30 | 309 | 4,219 |
| Zinc | 1,766 | — | — | — | — | — | 1,766 |
| Copper | 580 | — | 1,698 | 466 | 61 | 440 | 3,245 |
| Tin | 338 | 6 | 365 | — | 71 | 549 | 1,349 |
| Pig iron | 131 | — | 58 | — | — | 7 | 196 |
| Wolfram | 17 | — | — | — | — | — | 17 |
| Bismuth | 1 | — | 19 | — | — | 3 | 23 |
| Molybdenite | 4 | — | 17 | — | — | — | 21 |
| Gems | 37 | — | 43 | — | — | — | 80 |
| Other minerals | — | — | — | — | — | — | 415 |
| Total minerals | — | — | — | — | — | — | £25,629 |
| Manufacture. | | | | | | | |
| Material used | 37,122 | 27,003 | 11,079 | 8,199 | 2,586 | 2,287 | 88,276 |
| Value added | 24,041 | 18,408 | 7,720 | 5,239 | 3,506 | 1,585 | 60,500 |
| Total output | — | — | — | — | — | — | £148,776 |

Mr. Norris G. Bell, of the Queensland Railways, has been selected as the successor to Mr. Henry Deane, engineer-in-chief for the Commonwealth Railways. The salary attached to the position is £1800 per annum.

Trials have been made, but with unsuccessful results, of the burning of Australian coal on the ships of the Australian navy. The steaming is retarded by the amount of ash the coal makes. The British warships, when out in these waters, take supplies of Westport, N.Z., coal, which is considered to be equal to Welsh coal.

A statement has been made in the Commonwealth Parliament that the cost of construction of the Trans-Australian Railway will considerably exceed the estimate, which was approximately £4,000,000. The original estimate was based upon the use of earth ballast, but it is found that an expeditious service cannot be given unless the line is laid on solid ballast.

Mr. Julian King-Salter has been appointed by the Commonwealth Government to take charge of the Cockatoo Island Dockyard, Sydney, where the building of Australian warships has been commenced.

The Queensland mineral output for the past year is shown below, together with a comparison of the output of the preceding year:—

| | 1912. £ | 1913. £ |
|---|---|---|
| Copper | 1,698,289 | 1,660,178 |
| Gold | 1,477,979 | 1,128,768 |
| Coal | 338,264 | 403,767 |
| Tin | 364,503 | 343,669 |
| Silver | 66,188 | 68,438 |
| Lead | 55,667 | 65,683 |
| Wolfram | 57,821 | 35,359 |
| Bismuth | 16,426 | 17,867 |
| Molybdenite | 17,349 | 19,001 |
| Gems | 43,016 | 46,292 |
| Other | 39,862 | 68,859 |
| Total | £4,175,355 | £3,857,881 |

An offer is pending for the purchase by the Government of the Lithgow Ironworks, N.S.W., from Messrs. G. and C. Hoskins. These are the only blast furnaces in Australia. In the offer is included the firm's pipe-making works near Sydney, which are reputed to turn out more pipes than all the rest of the foundries in Australia put together.

## EARLY LOCOMOTIVES IN AMERICA.

We have to thank Mr. Dendy Marshall for allowing us to print the following interesting letter, which has recently come into his possession:—

Office, Baltimore and Susquehanna Rail-Road Co.,
Baltimore, March 8th, 1850.

Gentlemen,

In 1836, this company and the Wrightsville, York, and Geltysbury R.R. Co., contracted with you through the agency of A. and G. Ralston and Co., for two Locomotives each. This Company working the latter road purchased the two imported for them. Each Locomotive had four Excentrics and the Company is now threatened with a suit for an alledged infringement of a Patent right issued to Colº Stephen H. Long 17th Jany 1833 amongst other things, the use of *four excentrics*. Will you please inform me when you commenced using 4 excentrics and whether it was patented in England and if so when?

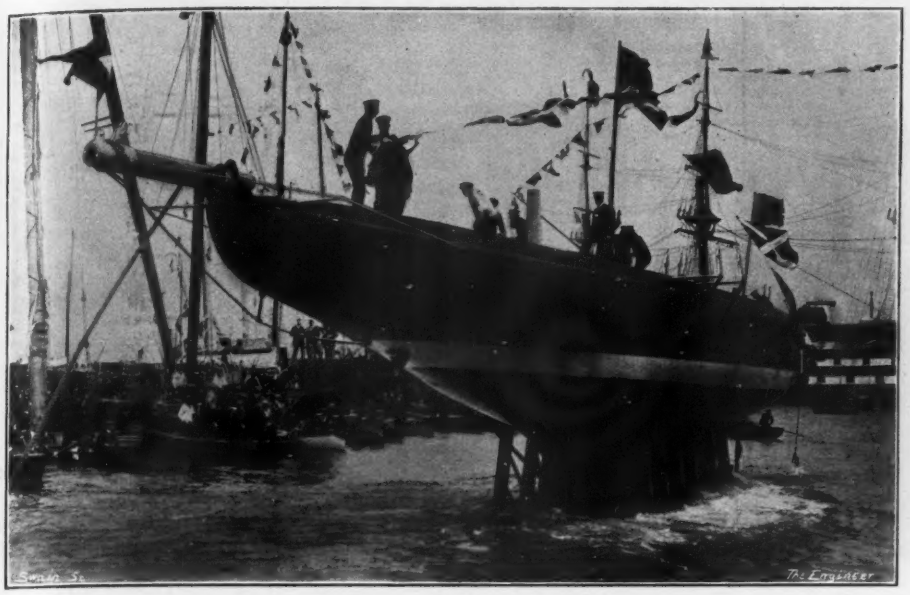
You built for this Company in 1831 a small Locomotive with four wheels but which had but two excentrics.

These five Locomotives are still running on our road, but have all been rebuilt.

Our Driving wheels from 4 to 5 feet diameter are entirely

# LAUNCH OF SHAMROCK IV.

CAMPER AND NICHOLSON, GOSPORT, BUILDERS



of *Cast* Iron, with chilled treads as our Pasenger and Burden Car wheels 33in. in diameter are cast.

Our preference is the *Cranked* Axle Locomotive, but the repeated breaking of the axle; Every Locomotive having broken one or more, we were induced to try *Cast Iron*, and after an experience of 5 years, we have adopted them entirely, never yet having broken a *Cast Iron Crank Axle.* I enclose a list and description of our Locomotives, with their power on a grade of 84 feet per mile or about 1 in 63 for a distance of 2½ miles. At foot I give you the Nos. of the Locomotives you built.

With respect I am
Gentlemen
Your obt servt
ROB. S. HOLLINS
Secty and Treasr.

Messrs. Robt. Stephenson and Co.
New Castle upon Tyne
England.

| | Names. |
|---|---|
| No. 146 | Harrisburg |
| ,, 147 | Wrightsville |
| ,, 151 | Chieftain |
| ,, 152 | Sampson |
| | Herald |

Mr. Marshall tells us that he has not got the list of locomotives referred to in the letter.

## THE AMERICA CUP CHALLENGER.

THE America Cup challenger—Shamrock IV.—which has been designed by Mr. Charles Nicholson, and built for Sir Thomas Lipton by Messrs. Camper and Nicholson, was launched at Gosport on Tuesday, May 26th last. A view of the vessel is given above. Her principal particulars are as follows:—Length on water-line, 75ft.; length overall, 110ft.; beam, 23ft.; draught, 13ft. 9in.; draught, with centreboard down, 23ft. 9in. Her keel, which is of lead, is 30ft. long. It weighs some 60 tons, and is round at the top and flat at the bottom. The vessel is to be cutter rigged, and her mast is 160ft. high. We understand that in all three masts have been made, two of these being of wood and one of steel. The bowsprit has an outboard projection of only 10ft.

Everything which could possibly be done to save weight, without sacrificing strength, has been effected, both hull and deck are built of several layers of thin wood with the grain running in different directions. There are five thicknesses of wood forming the deck, which is covered with canvas. The skin has three thicknesses, the grain of the outer thickness being horizontal and the grains of the other two cross, so as to get the grain running in three directions. The shape of the hull is somewhat peculiar, the bows being given a very bluff form.

IN his report for the past year on the trade of the consular district of Porto Alegre, Dr. T. Cantrell Dillon, the British Consul, says the greater part of the importation from Europe is from the United Kingdom and Germany, in about equal shares. Much of the machinery imported is of German make, but a new firm has been established which is selling British-made machinery. Agricultural implements and machinery—which are duty free—come principally from the United States. Enamelled goods come chiefly from Germany, as do cheap ironmongery and tools; the better kinds of these goods are of British manufacture. Welded iron tubes, lacquered and nickel-plated for manufacturing bedsteads, galvanised iron roofing sheets, tin-plates and hollow-ware come almost exclusively from the United Kingdom. Fencing wire formerly came principally from Belgium and Germany, but is now imported on a large scale from the United States, which country is making vast and rapid strides in trade in this country. Iron sheets, rods, bars, hoop iron and other similar products come chiefly from Germany. Pig iron is imported almost exclusively from the United Kingdom, as are copper bottoms and sheets.

## LETTERS TO THE EDITOR.

*(We do not hold ourselves responsible for the opinions of our Correspondents.)*

### AUTOMATIC COUPLERS FOR BRITISH RAILWAYS.

SIR,—I respectfully ask the courtesy of your columns to comment on the article which appeared in your issue of 22nd inst. on the appointment of a Committee by the President of the Board of Trade to inquire into the working of the Railway Employment Safety Appliances Act of 1900.

Had general managers in the past, as a body, perceived the best interests of their shareholders and their obligations to their employés, they could not have left this important question all these many years to spasmodic and isolated efforts as they did, but would have acted as the Royal Commission on Accidents of 1899 said ought to be done, viz., that "the companies voluntarily or by obligation should make those practical experiments which we have pointed out ought necessarily to precede the general application of any system of automatic coupling."

Had this been carried out in earnest railway managers would long ago have found out, what has still to be revealed to them in that very way, what some general managers more than suspect to-day, that the adoption of automatic couplings on wagons in this country will prove the very best paying of all the safety appliances urged on them and viewed by them hitherto as safety appliances only.

Instead of this, the Act of 1900 has been mainly contemplated as a financial burden on railways. The Board of Trade proceedings under it, to put it very mildly, were not encouraged, and the result is that fourteen years after that Act was passed the situation has to be reviewed to secure to the Board of Trade the full powers to do that which is permitted in the Act and which the railways ought to have done themselves, viz., ascertain by testing where the best automatic coupling suitable to this country could be had and under what conditions it could be best adopted on our railways.

Concerning the working of the Act, your article admits it took the Board of Trade from 1902 to 1911—ten years—to come to an arrangement—in which the companies defeated the Board of Trade—in the matter of either-side brakes.

Under this Act the Board of Trade could not order or enforce the adoption of an identical single pattern either-side brake on wagons, which is the only method of working under which the railways can obtain the quickest despatch, with safety to their employés, and consequent reduction in compensation charges. Then under the shadow of that Act railways negotiated permission for each railway to select its own pattern of brake with special leave to the larger railways to take their own time about it, with further opportunity to get that period extended if they apply at the end of thirty years from the date of the Act—a commercial transaction in which the safety of the lives and limbs of the workers, for whom the Act was passed, finds small place.

No one need wonder, therefore, that the Railway Employment Safety Appliances Committee found itself in a tight place concerning automatic couplings, and that in these fourteen years it has found itself powerless therein, and has had to swallow every *non possumus* argument put forward by railways against their adoption, and adopted as its own "the little necessity there was for automatic couplings and the engineering and financial difficulties in their adoption," every argument of which would have been exploded had the Board of Trade been free to carry out or compel the railways to carry out the practical experiments suggested by the Royal Commission of 1899.

With the either-side brake defeat the Committee dropped the question of practical experiments; but underlying their reports in the matter of improved and automatic couplings they had *under their observation* several appliances which, had due facilities been provided, would have done much to settle this question.

In the case of one automatic coupling the inventor undertook at his own cost to prove its working on English railways, provided due facilities were afforded him under the conditions of that Act; the Committee professed themselves powerless, and the Board of Trade had to do nothing "*for the present.*"

In the same fashion, with an apparatus for utilising the three links on wagons, the Committee being unable to provide under the Act the absolutely necessary running in regular traffic, that inventor was shunted for the present. Instances could be multiplied, but these must suffice.

During March and April of this year I travelled on the Erie and Pennsylvania and Delaware, Lackawanna, and Western Railroads, in the United States of America, and spent hours watching shunting with automatic couplings there—seeing goods cars of 60 and 70 tons each handled by automatic couplings with certainty and despatch. I come home to England to watch a brake van placed on the main line rails of railways on to which 10-ton wagons are shunted, strike that brake van's buffers and rebound some feet too far away to couple up by hand; I see three or more shunters bend their backs and waste a minute or two getting that wagon into position, the wagon being hand coupled just in time to clear the line for the express signalled over that same line of rails.

This sort of thing occurs day and night all over Great Britain, and the waste of time and energy, the needless cost to the companies, and the risk of various accidents to the workers, and to passengers, goes on, whilst the fact that the British railways' returns of accidents to their servants for 1913 show just 300,000 for ten years, calls aloud for action.

The United States, in spite of its reckless expenditure of life and limb of workers on its railroads, has its lesson for this country in automatic couplers. Whilst the railroad traffic there has vastly increased, its goods cars grow heavier and heavier, and general accidents to the worker mount higher year by year. Accidents in coupling and uncoupling vehicles *do not*, and as the inspection of the couplers there grows more keen, so will those accidents more and more proportionately diminish with extending traffic. In 1895 the goods cars of the United States railroads were about 30 tons; in 1914 they reach 70 and sometimes 90 tons, and by 1925 they will be far heavier. Their annual renewals to-day reach 250,000 cars, or over a million of our tons.

The business before the new Committee is to devise some means by which the very best appliances that can reduce that fearful total of 300,000 accidents shall be found and shall be made available for that purpose.

In Mr. John Burns, once an engineer and mechanical worker himself, we have one who can realise such a situation, and he may be trusted to act up to his convictions of the urgent necessity there is for making the clear intentions of the Act of 1900 hitherto held at bay by our railways, a reality and not a sham.

Northfleet, May 26th. T. A. BROCKELBANK.

### SURFACE COMBUSTION TEMPERATURES.

SIR,—The statements made in your interesting article on page 526 as to temperatures attainable by surface combustion are so remarkable, that, with all due respect, I feel called upon to comment on them. You state: "with coal gas or water gas about 1950 deg. Cent." is obtained. Now, the data as to specific heats I have for some time relied on, and which much experience has convinced me are very accurate, render such temperatures *theoretically impossible of achievement by the surface combustion method.* I do not believe in their practical attainment either, on the ground that no refractories of a commercially applicable nature would, on the one hand, withstand fusion at that temperature, and on the other, such very local heating without spelching. If Professor Bone has succeeded in evolving such refractories I should like him to give me the chance of selling bricks at the rate of 50 to 100 million per annum at a price of 4d. each on a commission of only 5 per cent. Magnesia is a very good conductor of heat at high temperature. Pure silica melts at 1830 deg. Cent. The limit of calorific intensity of combustion of coal gases is, according to the data alluded to, about 1600 deg., and I have attained 1780 deg. in a special furnace regenerating the air to a bright yellow heat. Now, if I am right in regarding the maximum temperature admissible of attainment with cold air and gas at, say, 1600 deg., it is certain that a much higher temperature can only be attained in ordinary fully regenerative furnaces, for substantially preheated air and gas would suffer pre-ignition in one of Professor Bone's furnaces.

I naturally feel great diffidence in offering these comments, but the matter is of such extreme interest and importance that I feel all doubts on the subject should be cleared up. Any person who, like myself, has spent much of his life in dealing with steel melting furnaces, knows what a Godsend a brick would be possessed of only 50 deg., let alone 150 deg., higher fusion point than best silica bricks. ALLEYNE REYNOLDS.

Hove, May 26th.

## LAUNCHES AND TRIAL TRIPS.

UBIER, steel screw steamer; built by Wm. Gray and Co., Limited; to the order of the Mercantile and Shipping Company, Limited, Antwerp; dimensions, 331ft. 6in., 46ft., and 23ft. 5½in.; engines, triple-expansion, 23in., 36½in., 62in. by 42in. stroke, pressure 180 lb. per square inch; constructed by Central Marine Engine Works; trial trip, May 12th.

VAN HOGENDORP, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Atlantic Fruit Company, Limited, of New York; dimensions, 343ft., 45ft. by 20ft. 2in.; to carry fruit; engines, triple-expansion, constructed by builders; a speed of 14 knots was attained on trial trip, May 14th.

PENGREEP, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Mr. R. B. Chellew, of Truro; dimensions, 402ft. 6in., 52ft. by 29ft. 6in.; to carry 8000 tons; engines, triple-expansion, 25½in., 42in. and 70in. by 48in. stroke, pressure 180 lb. per square inch; constructed by Richardsons, Westgarth and Co., Limited; a speed of 12½ knots was attained on trial trip, May 19th, 1914.

MACCLESFIELD, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of Great Central Railway Company; dimensions, 250ft. by 34ft.; to carry cargo and horses; engines, triple-expansion; constructed by the builders; launch, May 22nd.

MONGARA, twin-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the British India Steam Navigation Company, Limited; dimensions, 464ft. by 58ft. by 36ft.; engines, triple-expansion; a speed of 14¼ knots was attained on trial trip, May 22nd.

GARDENIA, steel screw steamer; built by the Tyne Iron Shipbuilding Company, Limited, Willington Quay-on-Tyne; to the order of the Stag Line, Limited, of North Shields; dimensions, 342ft. by 48ft. by 24ft. 6in.; to carry 5300 tons on a light draught; launch, May 23rd.

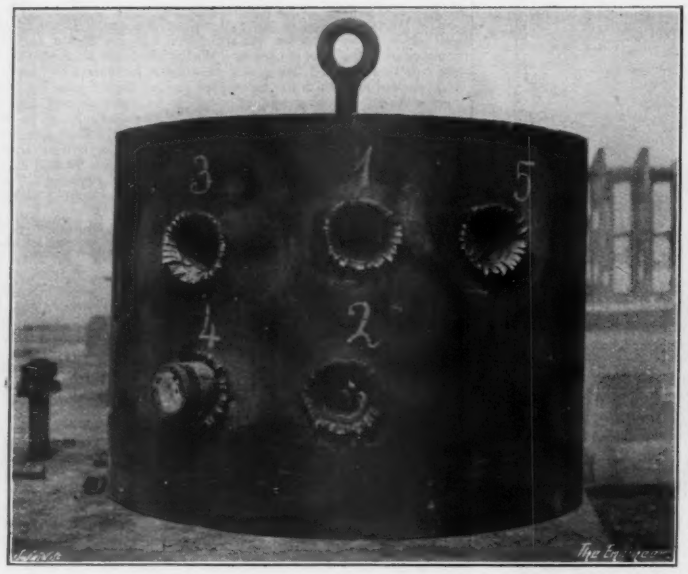
ARAGAZ, steel screw petroleum steamer; built by Sir W. G. Armstrong, Whitworth and Co., Limited; to the order of the Aragaz Tank Steamship Company, Limited, of London; dimensions, 400ft. by 50ft. 3in. by 30ft. 3in.; to carry petroleum; engines, triple-expansion, 25½in., 42in., and 70in. by 48in. stroke, pressure 180 lb. per square inch; constructed by the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne; trial trip May 25th.

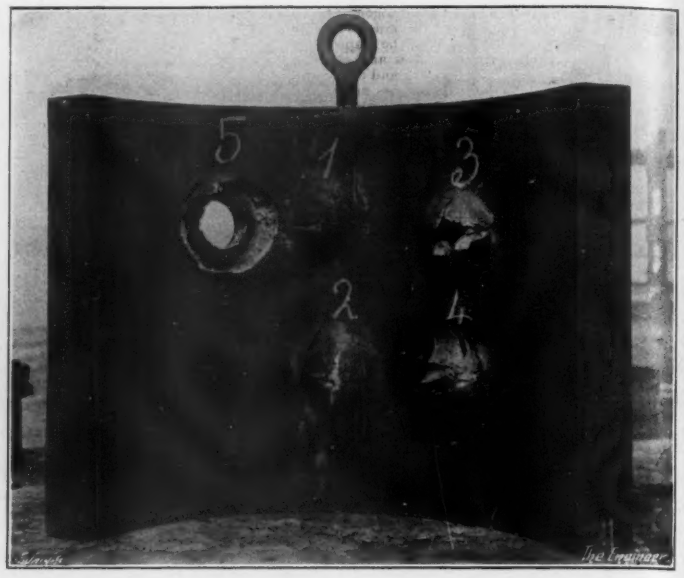
SAXONIAN, steel screw steamer; built by the Greenock and Grangemouth Dockyard Company, Limited; to the order of the Petroleum Steamship Company, Limited; dimensions, 374ft., 51ft. 3in. by 29ft. 4in.; to carry 6700 tons, conforming to Suez Canal regulations; engines, triple-expansion, 27in., 44in. and 73in. by 48in. stroke, pressure 180 lb. per square inch, constructed by Dunsmuir and Jackson, Limited; launch; recently.

MELITA, twin-screw motor yacht; built by J. I. Thornycroft and Co., Limited; to the order of H.I.H. The Grand Duke Cyril of Russia; dimensions, 100ft. by 15ft. by 8ft.; engines, two direct reversible paraffin engines, 8½in. by 12in. stroke, and develops 150 brake horse-power at 550 revolutions per minute; constructed by the builders; a speed of 13.65 knots was obtained over the measured mile and kept up for a period of four hours; trial trip, recently.

OPEN-TYPE motor launch; built by J. I. Thornycroft and Co., Limited; to the order of Mr. J. Ucovic, for use in the Adriatic; dimensions, 26ft. by 5ft. 6in. by 2ft.; four-cylinder motor, and develops 18 and 22 brake horse-power on paraffin and petrol respectively at about 1100 revolutions per minute; constructed by J. I. Thornycroft and Co., Limited; on trial trip a speed of 12¼ knots was attained; trial trip, recently.

# TESTS OF ITALIAN GUN SHIELDS




## TRIALS OF ITALIAN SIX-INCH SHIELDS.

*(By our Italian Correspondent.)*

THE first of a batch of 6in. shields made by Ansaldo was tried, uncemented, by the Italian Government Commission at the Castagna range, near Spezia, on May 14th. A 6in. (152 mm.) 40-calibre Armstrong gun, leaded with 4 r 12 balistite, and firing a Krupp projectile of 99.5 lb. (45.16 kilos.) was used.

*First Shot.*—Weight of charge, 8.48 lb. (3.85 kilos.); velocity of impact, 1410.76 foot-seconds (430 m.); the projectile entered the shield with its point and fell back.

*Second Shot.*—Weight of charge, 8.82 lb. (4 kilos.); velocity of impact, 1462.59 foot-seconds (445.8 m.); this was accepted as the velocity per contract. The effect on the shield was identical with that of No. 1.

*Third Shot.*—Weight of charge, 9.48 lb. (4.3 kilos.); velocity of impact, 1545.28 foot-seconds (471 m.); the same effect was produced as in Nos. 1 and 2, but the point of the projectile penetrated deeper.

*Fourth Shot.*—Weight of charge, 10.03 lb. (4.55 kilos.); velocity of impact, 1627.3 foot-seconds (496 m.); the projectile entered the shield for half its length and remained fixed.

*Fifth Shot.*—Weight of charge, 10.5 lb. (4.77 kilos.); velocity of impact, 1679.79 foot-seconds (512 m.); the projectile passed through the shield and was found close behind it.

This shot established the perforability of the shield at an impact velocity of 1666.66 foot-seconds (508 m.). Given therefore the fact that the velocity of impact to be withstood by the terms of the contract was 1463.25 foot-seconds (446 m.), the trials showed a margin of safety over and above the same of 203.41 foot-seconds (62 m.). Complete satisfaction was naturally expressed by the Government Commission with regard to the quality of the steel, which the accompanying photographs, giving the front and back views of the shield, will help to illustrate.

## GEARED CROSS-CHANNEL STEAMER FOR SOUTH AMERICA.

THERE was successfully launched on May 12th from the yard of Cammell, Laird and Co., Limited, Birkenhead, the turbine steamship Ciudad de Buenos Aires, the first of two vessels which are being built for the Argentine Navigation Company (Nicolás Mihanovich), Limited. These vessels are intended for cross-channel night service between Buenos Aires and Montevideo. Their principal particulars are as follows:—Length overall, 364ft.; length between perpendiculars, 350ft.; breadth moulded, 44ft.; depth moulded to awning deck, 23ft. 3in.; approximate draught, 10ft.; speed, 18 knots. Accommodation is to be provided for 494 first-class and 268 second-class passengers. The vessels have five decks, and are fitted with two high pole masts furnished with aerials for wireless telegraphy. They are classed A 1 at Lloyd's for channel purposes, and special attention has been paid to extra stiffening of the floors, stern frame, rudder, and bottom plating. The vessels are propelled by twin screws driven by geared turbines fitted in an engine-room amidships. Steam is delivered to the turbines from four cylindrical single-ended boilers working at a pressure of 170 lb. per square inch, and arranged for Howden's forced draught and to burn coal fuel. The boilers are placed in two separate compartments divided by a large cross-bunker with communicating passage between the two stokeholds. A complete installation is also supplied for one boiler to burn oil fuel when required. Water-tight side bunkers are fitted, the oil fuel being carried in the cellular double bottom in way of the engine-room. The propelling machinery consists of two sets of Parsons expansion geared turbines, the high-pressure turbine being placed in the centre and the low-pressure in the wings of the vessel. Weir dual air pumps, feed pumps, and "Uniflux" condensers of the latest types have been fitted. The construction of the hull throughout is of Siemens steel on the transverse frame system. A cellular double bottom extends well over half the length of the vessel. The fore peak is arranged as a tank for trimming purposes. Forward of the foremost boiler-room is a large hold extending the full width of the vessel and provided with trunk hatchways on the upper deck. Two smaller holds arranged aft of the engine-room are also fitted with trunk hatchways.

The steel water-tight lower deck, which forms a safety deck, extends from the stern of the vessel to the engine-room and from the boiler-room right forward. Access below is provided for by means of water-tight manholes. On this deck forward accommodation is arranged for seamen, trimmers, second-class passengers, and petty officers. Second-class accommodation for ladies is provided aft as well as in four-berth state-rooms leading off a general saloon. All the woodwork, inside and out, is finished in white enamel, all the steel work being cork dusted. These spaces are well lighted and ventilated by means of 10in. sidelights in the shell of the ship. The deck in way of the passenger spaces is covered with pine wood gratings, arranged in portable sections, while coir mats are placed at the foot of stairways. Accommodation is arranged for the crew right forward on the upper deck, which is also of steel sheathed with Canadian spruce. Abaft the foregoing first-class accommodation is arranged in two-berth cabins. Folding lavatories with water laid on are provided for all these cabins. Each cabin is arranged to provide in cases of emergency four sleeping berths. Amidships are large cabins for petty officers, second-class lavatories, and crews' wash-house and lavatories. At the ship's side and on either side of the engine casing are the engineers' cabins and second-class lavatory accommodation for ladies. Cold stores for provisions and the pastry shop are situated on the starboard side, while immediately abaft the engine casing is a galley sufficiently large for the full complement of passengers and crew and fitted with a lift to the first-class pantry on the promenade deck. The after end of the ship on this deck is almost entirely taken up by first-class cabins—exactly similar to those forward—and a large central saloon, in which is arranged a staircase leading to the deck above. Right aft are lavatories for ladies and gentlemen, as well as linen lockers and store-rooms. Partially made of steel, the awning deck is covered with teak outside the steel deck-house and Canadian spruce inside. This deck, which is fitted with a continuous waterway with teak grating covers all round, is devoted entirely to the accommodation of first-class passengers in 26 double-berth cabins, which can be arranged to accommodate either two or four persons. Each cabin is fitted with a mahogany folding lavatory specially designed to form either a seat or to serve as a step to the upper berth. In addition to the above state-rooms, there are specially designed cabins *de luxe*. Forward are four cabins provided with two single beds.

At the after end of the deck-house is fitted a large social hall, with an open marble fire-place at one end. The arrangement of the promenade deck is somewhat similar to that of the awning deck, 18 two-berth cabins and 26 two-berth and two sofa berth cabins being fitted. There are, in addition, four special cabins *de luxe*. At the after end and extending from side to side of this deck is a dining saloon with accommodation for 168 persons. A large open well in the centre admits of light passing to the awning deck saloon. A verandah *café* is situated quite close to the dining saloon. Specially designed French windows, oval in shape, admit light to the dining saloon and verandah *café*. Overhead and extending the full length of these rooms is a raised coach roof with rectangular sidelights and three stained glass skylights in the dome. Completely covering the promenade deck is a layer of stout heavily painted canvas, which has the appearance of linoleum, while along the corridors are fitted fine jute matting runners.

The boat deck is of Canadian spruce covered with stout heavily painted cotton canvas. Situated at the fore end of this deck is a large house containing chart-room, pilot's, officers', and captain's sleeping and sitting-rooms, first-class hospital, barber's shop, and captain's and officers' bath-rooms. On this deck also is placed amidships a large Marconi operator's house, containing office and cabin, and fitted with instruments for receiving and despatching wireless messages, while on the same deck are six steel lifeboats with one decked lifeboat under each. In addition, there are two steel motor boats and a dinghy made of teak for the captain. Suitable davits are provided for serving these and a steam boat, a hoisting winch having also been fitted for raising and lowering the boats as necessary. On this deck also are wood deck seats fitted with buoyancy tanks, which in case of need would permit of the seats being used as life-saving rafts.

Situated on the chart-house forward is a large wheel-house containing the necessary steering pedestal, compass, telegraphs, voice pipes, &c.

The steering of the vessel is effected by means of hydraulic steering gear controlled from the wheel-house forward and situated on the awning deck aft. Hand steering gear is also fitted. Cargo and heavy luggage is handled by means of four hydraulic cranes placed at the sides of the vessel on the upper deck. Hydraulic power is supplied by means of an installation of pumps, accumulator, &c., fitted in the engine-room. Aft and forward on the awning deck are fitted a steam warping capstan and a steam windlass of special design respectively, with large warping ends and cable whelps of steel designed to lift anchors and cables quickly.

The lighting throughout is on an extensive scale, while a powerful searchlight is fitted on the bow of the vessel. Current is supplied by means of two powerful dynamos situated in the engine casing at the level of the upper deck.

A fire-extinguishing system is provided, consisting of water pipes fitted on the underside of decks and hydrants above. Boxes containing hose, couplings, and directors are stowed near at hand, and, in addition to the water supply, steam pipes are led to the coal bunkers and holds, and are controlled from the upper deck. The hull is divided up by transverse and longitudinal steel bulkheads, and access to the various compartments is gained by means of sliding water-tight doors operated from the level of the upper deck.

The propelling machinery consists, as we have said, of two sets of Parsons compound geared turbines. This is an entirely new departure on the part of the Argentine Navigation Company, and is the more noteworthy in that no turbine machinery of any description has been fitted in any of its previous steamers. The gearing is placed at the after end and between each set of machinery, the vessels thus having two propeller shafts to which solid bronze propellers have been fitted. Each of the rotors for the high-pressure turbines is of steel, and has been forged in one piece. Low-pressure rotors are built up with a forged steel drum, a cast steel wheel, and forged steel spindles, the whole of the forgings having been made at the builders' steel works at Sheffield.

The boilers are fitted with Howden's system of forced draught, the air for combustion being supplied by two 72in. diameter steam-driven fans. Three furnaces of the Morrison suspension type are fitted to each boiler. The circulation of the water is assisted by hydrokineters. The screw shaft plummer blocks are lubricated by a syphon feed as well as by a grease lubricant, and a lubrication system is also fitted to the stern tubes. A new feature in connection with the machinery of these vessels is the adoption of the "Michel" type of thrust, which was decided upon on account of the considerable amount of surface gained and the satisfactory nature of its working on previous vessels built in this country.

The condensers are of Weir's type, with steel bodies and cast iron doors. The following auxiliaries, which are all of Weir's standard type, are installed:—Two dual air pumps of sufficient capacity to maintain a vacuum of 28in.; a pair of independent direct-acting feed pumps of the vertical type; two independent oil pumps for lubricating purposes; a general service pump and an evaporator, capable of producing 25 tons of water in twenty-four hours. In addition, there are a feed-water filter and a heater; two independent centrifugal circulating pumps; bilge pump, sanitary pump, an oil cooler for cooling the lubricating oil after it has passed through the bearings; also two small pumps for fresh water and sanitary purposes, and two "Sentinel" ash hoists. The hydraulic installation for working the steering engine, cranes, &c., is placed in the engine-room under the control of the engineer.

## THE USE OF SUPERHEATERS AND SUPERHEATED STEAM IN MERCANTILE STEAMERS.*

By Mr. HARRY GRAY, Member.

THE re-introduction of superheaters in boilers, and the use of superheated steam in engines of the mercantile marine, has been brought about by continuous research together with costly experiments, by the greater knowledge obtained in the process of making and amalgamating metals, by the improvements in the manufacture of such metals into tubes and other suitable forms, by the introduction of oxy-acetylene and electric welding, by the preparation of lubricating oils for use under high temperatures, together with a mass of data, the result of years of experimenting and investigation, and which has now been put to the crucial test of practical working.

Superheaters, when introduced into marine boilers some seventy years ago, developed rapid deterioration, producing such a heavy bill for repairs and renewals that they were regarded as too costly, not to say dangerous, for use on board a steamer, and it is possible that the experiences and the troubles which then developed have contributed to the extreme caution exhibited by many engineers and steamship owners in considering the *pros* and *cons* of the use of superheaters and superheated steam to-day.

In the *Mechanics' Magazine* of April, 1861, appears an article on "Superheated Steam," which is a most interesting record of what may be considered the last serious effort to give a superheat to steam for use in steamers, and the following extracts are taken therefrom :—"Mr. Thomas Howard is credited with establishing the fact that great economy might be effected by the principles of superheating in about the year 1833, and that Dr. Haycroft shortly afterwards urged its application on the ground that it would effect a saving of 30 per cent. in fuel. The Prince Alfred, of 200 horse-power, belonging to the Inter-Colonial Royal Mail Company, is stated as being 'the first seagoing vessel working with unmixed superheated steam and fitted with Partridge's system.' Other vessels mentioned are the Damascus, of 200 horse-power, the consumption per indicated horse-power being reduced to 3 lb. In the Tyne a vessel of 400 horse-power was fitted, and 'it was found very beneficial during a voyage from Southampton to Rio de Janeiro and back.' The H.M.S. Dee was fitted, and after four years was reported as in good condition. Altogether fifty vessels were fitted with 'Partridge's' apparatus, representing 10,000 to 12,000 horse-power, and the savings effected by the use varied from 15 to 30 per cent. In general, the steam was superheated to about 340 deg., and the pressure ranged from 10 lb. to 25 lb. per square inch. Other superheating apparatus mentioned are those of 'Parsons' and 'Pilgrims,' fitted on the Osprey in 1859, also H.M.S. tug Bustler in 1859, and in fifteen other vessels. Lamb's superheater, patented in 1858, was adapted to over fifty vessels with a saving of 20 to 40 per cent. Messrs. Boden and Clarke's superheaters were fitted on the Southampton in 1860, trading between Southampton and Channel Islands, of 262 horse-power condensing engines with two slide oscillating 60in. cylinders, 5ft. stroke. She burnt only 37 tons on each trip out and in, averaging twenty-two hours, or about 12 lb. per horse-power. The Dispatch was also fitted. Butler's superheater was fitted to the City of Nantes, with a saving of 30 per cent. and increased speed. Pullen, Cresswell and Longstaff's apparatus, patented in 1860, and many others which showed equally favourable results. Reference is also made to the researches of Dr. Taylor, Mr. Brande, Professor Faraday, Mr. Fairbairn, and others." Messrs. J. and W. Dudgeon, of Millwall, between 1859 and 1870 fitted about forty vessels with Beardmore's system of superheat.

The steam engine being essentially a heat engine, no excuse is needed for advocating the use of superheat ; if such were the case, however, the records of the past seventy years alone are full of instances of the devices brought out for steam jacketing, reheating, and other arrangements for retaining and maintaining the temperature in the cylinders. The drop in the temperature, not only between the boilers and the engines, but also in the cylinders themselves, beyond that due to the expansion of steam, has been, if not the greatest, at least one important cause of loss of power in steam engines, as it has thereby increased the amount of saturation in the steam.

Another loss arose from the amount of saturation brought over by the steam from the boilers, when priming was not violently taking place. This loss is seen more or less in all marine engines by the quantity of water which comes down through the piston-rod glands, to the detriment of the packing and the piston-rods. It is also manifest by the noise which betrays the presence of water in the cylinders, although there may be none of the usual evidence of priming in the boilers, which shows that whilst a small percentage might be attributed to condensation in the cylinders, a large volume is really due to the heavy state of saturation of the steam coming from the boilers, and, moreover, that this is a variable quantity, due no doubt to the conditions of firing, circulation, or the quality of fuel.

In order to obtain some data bearing upon this loss, measurements were taken of the water coming from the cylinders of quadruple-expansion engines of 3000 indicated horse-power working under saturated steam conditions, readings being taken during the voyage, and at times it was found that as much as 20 gallons per hour was drained off the M.P.2 and L.P. steam chests. The fact that such a quantity of water was found to accumulate in the cylinders of a quadruple-expansion engine, working under saturated steam conditions, convinced Mr. Alex. J. Dudgeon and the writer that superheat would convert this loss into effective horse-power and so contribute to a more economical result.

The modern system of superheating steam passes the saturated steam from the boiler through small tubes placed in different positions, according to the type of boiler, whether water-tube or marine cylindrical multitubular, usually termed the "Scotch" boiler. Some of these systems have been placed before the members of the Institution in papers read by Professor W. H. Watkinson, on "Some New Types of Superheaters," in 1903 ; by Monsieur Felix F. T. Godard, in "Notes on the Use of Superheated Steam with Marine Engines," in 1908 ; by Mr. Yarrow, on "Results of Experimenting with Water-tube Boilers with Special Reference to Superheating," in 1910 ; and also before the Institute of Marine Engineers by Mr. White, on "Marine Engines under Superheated Steam," in 1910.

It is not proposed to deal with the various points of interest regarding the different types or design of superheaters which naturally arise, but which do not come within the scope of this paper, which is confined to the experience of the use of superheat on steamers, with special reference to the important question of economy and cost of upkeep, based on over three years' working in engines of both triple and quadruple-expansion type in the mercantile marine engaged in a regular trade, voyage after voyage, to Australia *vid* the Cape of Good Hope.

In the system adopted—Schmidt's—the steam from the boilers passes into a vertical pipe called the "saturated" header placed in the smoke-box, from which small branch pipes are led horizontally across the front of the tube plates, the pipes passing down each tube of the row being doubled in a "U" form for that purpose, so that each "element," as it is termed, is a series of "U's," the other end being brought back to what is termed the "superheated" header. The jointing of each end of the element to the headers is effected by a small cross bar or "dog" with a stud through the centre, so that each dog makes two joints. Careful supervision, testing, and tightening up, as the pressure rises when getting up steam, prevents any leakages afterwards, as when once tight they do not give further trouble. A drain is fitted to both headers, that on the saturated header for blowing away any scum that might be brought over from the boiler, and which would possibly choke the lower rows of elements, and a drain on the superheated header to permit of a circulation of steam through the elements when getting up steam, or when the steam is not being circulated in consequence of the supply to the engines being shut off whilst working the engines to orders in ports.

The elements are examined periodically, being removed from each nest of tubes in rotation, so many each voyage, thus all are dealt with at least once a year ; but whenever the boilers are cleaned the ends of the elements are examined from the combustion chamber, as they are only about 9in. inside from the back tube plates, for any signs of leakage at the weld of the U bend of the elements. These defects are something less than .1 per cent. and are generally only pin-holes.

Even should it be necessary to deal with the U end, it is not a serious matter, either in time or expense, and, in the event of a serious leak, the steam from the boiler can be shut off the superheater and by-passed direct to the engines, whilst the defective element is withdrawn and the joints on headers re-made with blank plugs, the gross area through the elements allowing for a considerable reduction without unduly wire-drawing the superheated steam. Experience has shown no deterioration of the elements from corrosion or burning of the end, or any injurious action on the boiler tubes. The chief expense incurred with superheat is on account of extra labour when withdrawing these elements for inspection. None of the steamers under consideration have been delayed either in port or on the voyage from defects in superheater elements since being fitted, notwithstanding the fact that they are turned round quickly and have long runs, that of the Port Augusta being forty-five days without a call at any port, and the Port Lincoln and Port Macquarie thirty-nine days, with a call of a few hours only at Capetown for coal and fresh water.

The cleaning of the tubes on the voyage is effected by "Diamond Blowers" fitted in each combustion chamber, and they are blown through every day, the operation taking about two or three minutes for each nest, the soot which accumulates in the smoke-box being cleared away through the doors provided for the purpose. These blowers can be fitted to double-ended as well as single-ended boilers.

The absence of moisture, upon which marine engines rely for internal lubrication, makes the lubrication of the cylinders and valve faces of most vital importance when superheated steam is used. In the first instance, an excess of internal lubrication is advisable, until the pores of the metal surfaces become saturated and filled up with oil. When this has taken place it will be found that, although the surface of the cylinder walls may be cleaned and wiped when they are hot, upon the metal cooling down a film of oil will be squeezed out of the pores on to the surface of the metal ; when this condition has been attained, the quantity of oil for internal lubrication may be reduced with safety.

On the Port Augusta, of 2000 indicated horse-power, 1.5 gallons per day of cylinder oil were used at first for internal lubricating and swabbing of piston-rods of both main and auxiliary engines ; on the Port Lincoln and Port Macquarie, of 4000 indicated horse-power, about 2 gallons per day, this being gradually reduced until now only .5 to .75 gallon is required.

Another important detail with regard to this is that independent means of lubrication must be provided for each engine, either in the valve chest or cylinder. That for the high-pressure cylinder should be on the engine side of the stop and throttle valve, otherwise the surfaces are liable to become coated with an oil deposit during a long run, and may cause them to work stiff, thereby interfering with their steam tightness when brought into use again on working the engines to orders. It is advisable to arrange for independent lubrication for the low-pressure valve, as, owing to it being generally of the flat "D" type and unbalanced, the large surface, even with a low pressure upon it, gives rise to considerable friction.

It has been found in triple-expansion engines, where the medium-pressure cylinder is placed adjoining the high-pressure cylinder with short exhaust passages, that, after the surfaces become saturated with oil, the regular supply to the medium-pressure cylinder may be shut off, as it would appear that a sufficient quantity of the oil injected into the steam in the high-pressure valve chest becomes vaporised, and is carried over the medium-pressure valve chest with the exhaust. Nevertheless, in the first instance, a regular supply should be injected into the medium-pressure valve chest, and even when this is shut off a little extra oil should be injected from time to time, according to the evidence of the running and condition of the surface when opened up for examination.

The selection of a suitable lubricant for internal lubrication under the temperatures and conditions met with when using superheated steam is one requiring consideration. There are several oils on the market with a flash point under the open or atmospheric test of from 610 deg. to 630 deg. Fah., but due consideration must be given to their composition, whether an absolute mineral oil or a compound of a mineral with an animal or vegetable oil, which, it is claimed, adds to the lubricating qualities without creating troubles from carbonisation or other causes ; this, however, is a doubtful point. Upon the question of the evaporation point and also the flash point, when the oil is under pressure, we know of no reliable data ; possibly these points are higher under pressure than those obtained by the tests under atmospheric conditions.

It is absolutely necessary to have a reliable system of filtration for the feed water, so as to ensure the abstraction of the oil and safeguard the boilers from the possibility of any traces getting through. The difficulties at first met with to obtain this result have been overcome by fitting a large gravitation filter.

The whole secret of filtration is "time" to allow the feed water to come almost to rest and enable the oil to rise to the surface and be collected ; afterwards the feed water should pass through a chamber filled with coke, and finally through a section fitted with "cartridge" cylinders, covered with filter cloth towelling of substantial body having a rough surface. The more compartments of the first or settling stage that are provided the longer the coke and filter cloth sections will last without requiring to be changed. The filter must be so placed that the water will gravitate to the same water level as the weir in the hotwell of the air pumps. It is essential that the covers of this filter should be always open when working so that it may be under observation, and that the thick scum accumulating on the surface of the settling chambers may be removed by hand from time to time.

The cleaning of the coke and filter cloth chambers can be done very quickly if a full set of spare parts are carried, which can be kept charged with fresh coke and with clean filter cloths on ready for use. When such spare parts are provided there is no necessity for a by-pass arrangement, as the working of the filter is not interfered with during the process of changing the filtering medium, and the time is so short that no danger from oil passing through with the feed water is experienced.

The feed water betrays not the slightest sign of oil in emulsion when drawn off from the feed pumps ; there is no "taste" of oil perceptible ; the internal surface of the boilers, even on the water-line, do not show any signs of oil, and this has been confirmed in each of the four boilers in both the steamers with quadruple-expansion engines having passenger certificates, upon inspection at the end of six and twelve months' service, as well as at the annual survey on the other steamer, fitted with triple-expansion engines and two boilers.

The temperature of the steam during the various stages is ascertained by pyrometers fitted to the superheater steam pipe of each boiler, to the high-pressure and medium-pressure 1 steam chests, and by thermometers fitted in the steam chests of the medium-pressure 2 and low-pressure engines. The general experience with the pyrometers having long connecting capillary tubes filled with ether or mercury, by means of which the temperature is recorded on the dial, shows a tendency to give unduly low readings after months of constant use, to the extent of about 5 per cent., necessitating their being frequently tested, and short connections are therefore recommended, although the position of the dials may not then be so conveniently arranged for observation. The variations in the readings of the pyrometers, due to the fluctuations of the temperature of the steam following on the condition of the fires, indicate beforehand the rise or fall of the steam pressure, and enable the engineer on watch to know in which boiler the furnace temperatures are falling, through the fires getting low or dirty, and so give the necessary orders to maintain a full steam pressure.

The fitting of pyrometers and thermometers in this manner has given some very interesting information as to how far the superheat is carried through the engine ; in other words, whether the temperature of the steam due to superheat falls more or less quickly than the temperature of the steam consequent upon the pressure, so as to indicate at what stage, if any, the steam loses all "superheat" and returns to the "saturated" state.

The following table, which is approximately reliable, gives the average results obtained, although the higher temperature taken by the pyrometers may, as before mentioned, be lower than was actually the case :—

*S.S Port Augusta.*

| Steam chest. | Triple-expansion engines. | | | |
|---|---|---|---|---|
| | Gauge pressure in steam chests. | Temp. due to steam pressure. | Temp. recorded. | Degree of superheat. |
| | lb. | Deg. Fah. | Deg. Fah. | Deg. Fah. |
| High pressure .. .. | 160 | 370 | 550 | 180 |
| First intermediate .. | 53 | 300 | 400 | 100 |
| Second intermediate .. | — | — | — | — |
| Low pressure .. .. | 10 | 240 | ? | ? |

*S.S. Port Lincoln and Port Macquarie.*

| Steam chest. | Quadruple-expansion engines. | | | |
|---|---|---|---|---|
| | Gauge pressure in steam chests. | Temp. due to steam pressure. | Temp. recorded. | Degree of superheat. |
| | lb. | Deg. Fah. | Deg. Fah. | Deg. Fah. |
| High pressure .. .. | 206 | 389 | 600 | + 211 |
| First intermediate .. | 97 | 335 | 460 | + 125 |
| Second intermediate .. | 38 | 284 | 290 | + 6 |
| Low pressure .. .. | 9 | 237 | 220 | − 17 |

It will be seen that superheat is showing in the steam chests of the first three engines and almost in the low-pressure, while at times a few degrees of superheat are reported to have been actually registered there. The cut-offs are about :—High-pressure, 73 per cent.; medium pressure 1, 70 per cent.; medium-pressure 2, 70 per cent.; low-pressure, 70 per cent.

The steamers from which these data were obtained belong to Messrs. W. Milburn and Co., of London, and our thanks are due to Mr. Milburn for his permission to place the results before the Institution.

The Port Augusta was built and engined by Messrs. Hawthorn. Leslie and Co. in 1906 ; the boilers were fitted with superheaters, and the necessary alterations made to the engines, &c., by the North-Eastern Marine Engineering Company, Limited, of Wallsend-on-Tyne, in May, 1911, when the boilers and engines were five years old.

The Port Lincoln and Port Macquarie were built by Messrs. Hawthorn, Leslie and Co. and engined by the North-Eastern Marine Engineering Company, Limited, of Wallsend, in 1912. The boilers were designed for working the engines under saturated steam requirements, but fitted with superheaters.

The Port Albany was also built by Messrs. Hawthorn, Leslie and Co. and engined by the North-Eastern Marine Engineering Company, but the boilers were designed for and fitted with superheaters.

| Particulars. | Port Augusta. | Port Lincoln. | Port Macquarie. | Port Albany. |
|---|---|---|---|---|
| Length | 380ft. 6in. | 425ft. 9in. | 425ft. 9in. | 425ft. 9in. |
| Breadth | 49ft. 1in. | 54ft. | 54ft. | 54ft. |
| Depth, moulded | 28ft. 7in. | 31ft. 10½in. | 31ft. 10½in. | 31ft. 10½in. |
| Gross tonnage | 4063 | 7,236 | 7,236 | 7,236 |
| Deadweight | 7226 | 9,254 | 9,254 | — |
| Engines | Triple | Quadruple | Quadruple | Quadruple |
| Cylinders | 27in., 45in., 74in. | 27½in., 39in., 56in., 81½in. | 27½in., 39in., 56in., 81½in. | 27½in., 39in., 56in., 81½in |
| Stroke | 48in. | 54in. | 54in. | 54in. |
| Indicated horse-power on voyage | 2100 | 4,100 | 4,100 | 4,100 |
| Boilers, number | Two | Four | Four | Four |
| Boilers, type | Cylindrical single-ended | Cylindrical single-ended | Cylindrical single-ended | Cylindrical single-ended |
| Total heating surface | 5720 | 11,600 | 11,600 | 11,360 |
| Total grate surface | 137 | 240 | 240 | 260 |
| Total superheat surface | 2390 | 4,000 | 4,000 | 4,320 |
| Working pressure | 180 | 220 | 220 | 220 |
| Extreme diameter of boiler tube plain | 2¼in. | 2⅜in. | 2⅜in. | 3in. |
| Extreme diameter of boiler tube stay | 2¼in. | 2⅜in. | 2⅜in. | 3in. |
| Interior diameter of superheater tubes | 13 mm. | 13 mm. | 13 mm. | 15 mm. |
| Forced draught | Howden | Howden | Howden | Howden |

In the case of the Port Augusta no alteration was made to the boilers, the grate surface, or any of the saturated steam connections, the only change or addition being in the case of pipes or connections coming in contact with the superheated steam, and some modification was made to the smoke-boxes to allow of the superheater headers being fitted. The alterations to the engines consisted, in addition to the usual general overhaul, of fitting a balanced flat valve in place of the ordinary "D" valve for the medium-pressure engine, fitting of suitable piston-rod metallic packing, steel neck bushes instead of brass,

* Institution of Naval Architects.

and additional lagging to cylinders, &c. A gravitation filter was installed and afterwards enlarged and improved until its efficiency was satisfactory.

The Port Lincoln and Port Macquarie are duplicate vessels in every respect; they have no auxiliary boiler, so that all demands for steam are supplied by the main boilers; these are increased above the usual requirements of auxiliaries owing to the vessels being fitted up for emigrants, which necessitates additional galleys, pantries, refrigerator machine, and electric light. The Port Albany is a duplicate of the Port Lincoln, but fitted for carrying frozen cargo, and not fitted for emigrants.

Before dealing with the tabulated results of the performances of the steamers under consideration some description of the data available and the basis on which the deductions have been drawn is essential for the purpose of arriving at their value, not only to engineers, but also to shipowners.

Mercantile steamers are for the commercial purpose of carrying passengers and cargo at remunerative freights, and to do so the cost of running involves a heavy expenditure for fuel, either coal or oil; the ordinary means of ascertaining such expenditure on the fuel account is by calculating the tons of fuel used per day.

The data for this purpose are obtained from the voyage abstracts of the engineers' log book, which latter is also available for the verification of the daily averages as set forth in the abstract sheet. These data when covering a number of consecutive voyages assume a value, and in general practice are accepted as a fair basis of comparison, so that, with a known consumption of tons of coal per day, the quantity in bunkers required for a definite number of steaming days can be ascertained. The amount of coal required for loading and discharging cargo and other purposes is estimated separately according to the conditions and circumstances of the voyage.

The tabulated results are therefore not compiled upon data such as are available in a laboratory, on the "test" table, or even on a "trial trip" with a special staff of engineers to collect the same over a few hours or perhaps days, but they are the averages of months and years of every day's work, which for commercial purposes is the best guide as representing what the shipowner has to pay for.

The data available with the triple-expansion engines of the Port Augusta comprise seven consecutive voyages extending over three and a-half years using saturated steam, as well as the five following voyages after being fitted with superheat, extending over three years, all of which are from London to Adelaide *vid* the Cape of Good Hope, most of them being without any call at an intermediate port. The reason that the outward voyages have been taken is, not only that they cover the same run, but also because the same bunkers for the whole voyage were taken either on the Tyne or at Middlesbrough from the Auckland—Durham—or Mickley coal seams. The conditions, therefore, are exceptional, if not unique, for the purposes of comparison.

The data dealt with of the quadruple-expansion engines of the s.s. Port Lincoln and Port Macquarie are on exactly the same basis as that of the Port Augusta, and cover three voyages of each steamer to Melbourne from London calling at the Cape, with this difference, that two-thirds of the bunkers for the voyage were Mickley coal—unscreened—and one-third Natal coal, which latter gives a higher percentage of loss—ashes, &c.—and consequent consumption, than the North Country coal. There is also a deduction of 2 tons instead of 1 ton a day, on account of these steamers carrying more than 600 emigrants, besides a crew of 125, or about 740 souls all told, entailing a heavy expenditure of coal for galley fires, bakers' ovens, and steam for cooking presses, boilers, pantry sinks, plate heaters, &c.

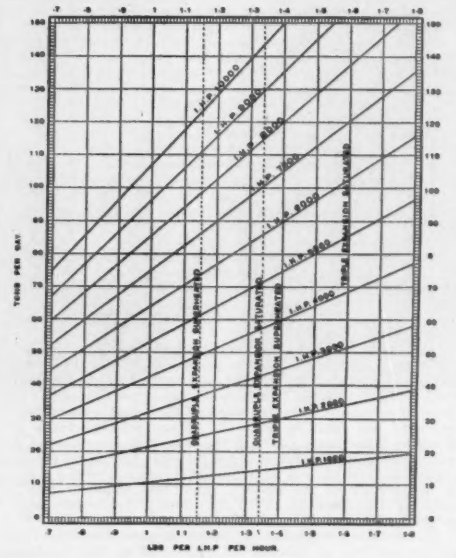
viz., Auckland or Mickley, was burnt as was used on the other steamers. In the case of the voyage averages of the Port Lincoln and Port Macquarie the consumption works out at 1.29 lb. per hour per indicated horse-power in consequence of one-third of the coal being from Natal, giving a higher percentage of loss.

*Economy and Saving of Coal in Tons per Day per* 1000 *Indicated Horse-power.*

Triple-expansion superheated at 1.4 lb. per indicated horse-power per hour over triple-expansion saturated at 1.6 lb. per indicated horse-power per hour; economy, 12.14 per cent.; saving, 2.14 tons per day per 1000 indicated horse-power.

Quadruple-expansion saturated at 1.34 lb. per indicated horse-power per hour over triple-expansion saturated at 1.6 lb. per indicated horse-power per hour; economy, 16.25 per cent.; saving, 2.79 tons per day per 1000 indicated horse-power.

Quadruple-expansion superheated at 1.15 lb. per indicated horse-




power per hour over triple-expansion saturated at 1.6 lb. per indicated horse-power per hour; economy, 28.1 per cent.; saving, 4.82 tons per day per 1000 indicated horse-power.

Quadruple-expansion superheated at 1.15 lb. per indicated horse-power per hour over triple-expansion superheated at 1.4 lb. per indicated horse-power per hour; economy, 17.85 per cent.; saving, 2.68 tons per day per 1000 indicated horse-power.

Quadruple-expansion superheated at 1.15 lb. per indicated horse-power per hour over quadruple-expansion saturated at 1.34 lb. per indicated horse-power per hour; economy, 14.2 per cent.; saving, 2.03 tons per day per 1000 indicated horse-power.

| Average of consecutive voyages. | S.S. Port Augusta. Triple-expansion. With saturated steam. | S.S. Port Augusta. Triple-expansion. With superheated steam. | S.S. Port Lincoln and Macquarie. Quadruple-expansion. With superheated steam. |
|---|---|---|---|
| Port Augusta, London to Adelaide, *via* the Cape | 7 | 5 | — |
| Port Lincoln and Port Macquarie, London to Melbourne, calling at the Cape | — | — | 6 |
| Days on voyage | 46 d. 10 h. 46 m. | 49 d. 12 h. 2 m. | 41 d. 1 h. 35 m. |
| Days under steam | 45 d. 17 h. 38 m. | 46 d. 14 h. 1 m. | 39 d. 2 h. 43 m. |
| Boiler pressure in pounds per square inch | 180 | 180 | 220 |
| Speed per hour in knots | 10.67 | 10.46 | 12.7 |
| Draught—mean—leaving London | 24ft. 9½in. | 24ft. 5½in. | 24ft. 10⅛in. |
| Displacement leaving London, tons | 10,150 | 10,000 | 12,266 |
| Coals used for all purposes | 1,744 | 1,560.45 | 2,335.05 |
| Less deductions for raising steam, banked fires, winches, galley fires, crew's bogies and condensing fresh water | 34 | 15.0 | 61.88 |
| Coals used for main boilers for supplying steam on voyage for main engines and auxiliaries also steering gear and electric light | 1,710 | 1,545.45 | 2,273.17 |
| Less deduction for Port Augusta steering gear and electric light at 1 ton per day | 46 | 49.5 | — |
| Less deduction for Port Lincoln and Port Macquarie, including also steam cooking process and boilers and provision refrigerator machine at 2 tons per day | — | — | 81.9 |
| Coals used for main engines and auxiliaries—circulating pump, feed pump, evaporator, and fan | 1,664 | 1,495.95 | 2,191.27 |
| Coals per day, tons | 36.65 | 32.1 | 56.0 |
| Coals per indicated horse-power in pounds per hour | 1.6 | 1.4 | 1.29 |
| Quality of coal as indicated by loss reported voyage—ashes, *&c.* | 14 per cent. | 13 per cent. | 16.4 per cent. |
| Indicated horse-power | 2,102 | 2,005.4 | 4,027 |

The above results cover all the contingencies which arise on a long sea voyage—weather, adverse trade winds, currents, also coal troubles arising from its being only "fair," or what is described as "dirty" or "small"; further, the human element is included, a most important factor affecting voyage results. Therefore these data have a special value to the shipowner.

The engineer naturally asks for a higher standard by which to gauge the capabilities and possibilities of the use of superheat; for this reason the results of a selected voyage from London to Capetown of one of the steamers fitted with quadruple engines are given when the coal was described as "good" but "small," the weather was "fair to good," and the stokehold crowd well up to the average. Then we get:—

| | Selected. | Average of five voyages. |
|---|---|---|
| Days on passage | 19 d. 10 h. | 19 d. 17 h. 28 m. |
| Speed | 12.92 knots | 12.77 knots |
| Coal consumption per day for main engines and auxiliaries | 50.33 tons | 51 tons |
| Coals per indicated horse-power | 1.043 | 1.15 |
| Indicated horse-power | 4500 | 4122 |

The part of the voyage from the Cape to Australia is generally more detrimental to exhibition results owing to weather conditions, as well as to the less satisfactory quality of Natal bunker coal taken at the Cape, which consequently increases the daily consumption without any increase of indicated horse-power. From the results obtained we get the following consumption:—

| | |
|---|---|
| Triple-expansion, saturated | 1.6 lb. per I.H.P. per hour |
| Triple-expansion, superheated | 1.4 " " " |
| Quadruple-expansion, saturated | 1.34 " " " |
| Quadruple-expansion, superheated | 1.15 " " " |

The figures for quadruple engines with saturated steam are taken from similar data of two steamers fitted with engines of 3000 indicated horse-power during seven voyages each to Australia *vid* the Cape, with the same bunkers as used for the superheated quadruple engines as far as the Cape already dealt with.

In the following comparison of the economy obtained the consumption for quadruple engines superheated is taken at 1.15 lb. per hour per indicated horse-power obtained on the voyage as far as the Cape, because coal from the same collieries, These results are shown on the diagram annexed up to 10,000 indicated horse-power.

The additional cost of fitting superheat cannot be set down at any definite figure, as although a large number of installations have been fitted, the different conditions that have to be complied with make a comparison, in order to form a standard of price, very conflicting; still, for rough estimating it may be taken as ranging from 15s. to 20s. per indicated horse-power, against which the reduced size and consequent cost of the boilers must be considered.

The full benefit of superheat can only be obtained by extending its use to all the auxiliaries, and this has been carried out on the vessels fitted when new. The steam pipes are of steel and gland packings, mostly metallic. The temperature used is about 500 deg. Fah. and is regulated by a mixing valve from the saturated steam pipe line. This arrangement ensures dry steam to the auxiliaries without any injury, although they are not all specially constructed for the use of superheated steam. Most of the leading makers of auxiliary engines make the necessary alteration for moderate superheat with but little, if any, extra charge. The mixing of superheated steam with the saturated supply for the winches is also a great advantage, even though very little superheat, if any, gets so far.

The use of superheat on turbines is another and most interesting phase of the subject, and one on which a *résumé* of experience would be most valuable whether on the turbine direct or after passing through the reciprocating engine. The data on the use of superheated steam during the last three years contained in this paper has been collected by the writer's firm in their professional capacity of consulting engineers to the owners of the steamers. The fact that superheat has been fitted in all their subsequent vessels built, after a careful comparison as judged from the owners' standard of coals paid for, prompted the writer to place this information before the members of the Institution as pointing to the facts:—

(1) The economy of coal claimed is maintained.

(2) The economy with triple-expansion engines of 2000 indicated horse-power after being altered to use superheat has been 12.14 per cent.

(3) The economy with quadruple-expansion engines fitted with superheat over triple-expansion similarly fitted is about 17.85 per cent.

(4) The wear on the machinery is not appreciably increased where proper lubrication of internal surfaces is maintained.

(5) The filtration of oil from the feed water has been successfully carried out so as to ensure the satisfactory condition of the same.

(6) No danger from oil getting into the boiler need be feared with a filter such as was used.

(7) The arrangement and fitting of the superheater elements and pipe connections present no serious objections.

(8) The maintenance of the superheater elements in an efficient condition requires only ordinary attention.

(9) In using superheat there is no necessity to carry any additional spare gear.

(10) There is no necessity to carry any spare superheater elements.

(11) The first cost has been recovered in one year on the basis that the vessel is under steam for 200 days, as a result, not only of the saving of bunker coal, but also of the additional freight carried in lieu of the weight saved thereby. In subsequent years the whole gain is for the profit of the shipowner, subject to, say, 5 per cent. of the same for additional overhaul and maintenance of the superheater elements, &c., and the usual allowances for insurance and depreciation on first cost.

(12) All that is required to obtain these benefits is to instil confidence into the engineers in charge, and to see that the working instructions are implicitly carried out.

The number of steamers fitted with superheaters during recent years is an indication of successful working under superheat conditions. The following figures, though far from being a complete record, are worthy of note and consideration:—

| | No. of steamers. | Total I.H.P. |
|---|---|---|
| Hide superheaters | 20 | — |
| Yarrow superheaters | 13 | 261,000 |
| Babcock and Wilcox superheaters | 29 | 316,675 |
| Thornycroft superheaters | — | 60,000 |
| Schmidt's superheaters | 1042 | 1,322,692 |

## FORTHCOMING ENGAGEMENTS.

### TO-DAY.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. Professor J. C. Bose, on "Plant Autographs and their Revelations." 9 p.m.

### THURSDAY, JUNE 4TH.

THE INSTITUTION OF MINING ENGINEERS.—In the Rooms of the Geological Society, Burlington House, Piccadilly, London, W. 11 a.m. The twenty-fifth anniversary of the foundation of the Institution will be celebrated at a dinner to be held at the Hotel Cecil in the evening, 7 p.m. for 7.15 p.m.

### FRIDAY, JUNE 5TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. The discourse will be delivered by Professor William H. Bragg, F.R.S. The subject is "X-Rays and Crystalline Structure." 9 p.m.

### FRIDAY AND SATURDAY, JUNE 5TH AND 6TH.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Visit to Dunfermline. For programme see page 606.

### TUESDAY, JUNE 9TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH LOCAL SECTION.—Annual summer outing. Leave Central Station, Glasgow, for Wemyss Bay at 9.30 a.m., thence per steamer *vid* Kyles of Bute to Arran, arriving Whiting Bay at 1.40 p.m., returning at 2 p.m. *vid* Garroch Head.

### THURSDAY TO SATURDAY, JUNE 11TH TO 13TH.

THE INSTITUTION OF WATER ENGINEERS.—Summer meeting at Stockport. For programme see page 578.

### MONDAY TO SATURDAY, JUNE 15TH TO 20TH.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.—Nineteenth annual Convention at Birmingham. For programme see page 566.

### TUESDAY, JUNE 16TH, TO FRIDAY, JUNE 19TH.

THE INSTITUTION OF GAS ENGINEERS.—Annual meeting at Liverpool.

### WEDNESDAY, JUNE 17TH.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS, LONDON.—At Caxton Hall, Westminster. "The Evolution and Development of the Internal Combustion Railway Locomotive," by Mr. W. P. Durtnall. 7.30 p.m.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

MESSRS. J. S. WITHERS AND SPOONER, chartered patent agents, will remove on June 1st next from 323, High Holborn, to Staple House, 51 and 52, Chancery-lane, London, W.C.

MR. J. ALLEN PICKARD, B.Sc., A.R.C.Sc., A.I.C., asks us to state that he has commenced practice as an analytical and metallurgical chemist at 50, Crooms-hill, Greenwich, London, S.E.

MR. JOHN SHERRATT, general superintendent of the White Star Line at Genoa, who is about to retire, after thirty-two years of active service, has been presented by his employers with a silver salver.

PROFESSOR JOHN PERRY, F.R.S., has recently retired from the staff of the Imperial College of Science and Technology, and we are informed that a fund is being raised for the purpose of giving expression to the appreciation of his services to the teaching of mathematics and to engineering education. An appeal for subscriptions has been issued to his former students and colleagues at the Imperial College and at Finsbury Technical College, but there are doubtless many others who have benefited by his published works and who will desire to subscribe to the testimonial fund. The testimonial will take the form of a medal or prize to be presented annually, as well as a personal presentation. Past and present students of the Imperial College are asked also to note that another fund is being raised for a testimonial to Professor Jos. Harrison. Subscriptions should be sent to the hon. treasurer, Mr. P. T. Wrigley, M.A., Royal College of Science, South Kensington, S.W.

CONTRACTS.—Ed. Bennis and Co., Limited, have received a series of orders for a total of sixty-eight stokers and furnaces of various type, for a coal elevator, and for a coal elevator and conveyor.

IRON AND STEEL INSTITUTE.—In the report of Mr. Greville Jones' remarks in the discussion on Mr. Müller's paper on "The Development of Dry Cleaning in Blast Furnace Gas Purification," we quote him as saying: "After passing through the bags the dust in the gas did not exceed .035 grammes." We are requested to say that the figure should be .015, and not .035.

# THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

*(From our own Correspondent.)*

### Birmingham Pig Iron Market.

PIG iron is selling only from hand to mouth and buyers are not able to turn their control of the market now to further account owing to the low level to which values have already fallen. On 'Change to-day—Thursday—in Birmingham some moderately good sales of raw material were reported in a few quarters, not enough, however, appreciably to relieve the prevailing dulness. South Staffordshire common forge iron was obtainable at 48s. to 49s., while part-mine varied from 50s. to 51s. Best all-mine Staffordshire forge hot air iron was quoted at 85s. to 90s., and foundry at from 87s. to 92s. 6d. per ton. Cold blast iron remains at 125s. Northampton forge iron can be bought down to 47s. 6d., and from this minimum it ranges up to 49s. according to quality. Derbyshire agents ask 51s. and upwards.

### Merchant and Common Bar Trade.

There is still a fairly steady flow of business in the direction of the best bar houses. Makers could do with more orders, but they are not likely to obtain them by reducing the standard, hence the £8 10s. basis may be taken as fixed for the time being. Merchants report a good many orders for medium class bars. They are of small dimensions, and the mills are very irregularly employed. Prices move between £6 7s. 6d. and £6 10s. at works; in some cases £6 5s. has been accepted. Nut and bolt iron for the Darlaston and Wednesbury trade is selling slowly at £6 2s. 6d. to £6 5s. delivered. Quotations for Belgian No. 3 quality are as low as £5 7s. to £5 8s. 6d. net. There is a discount of 2½ per cent. on the local production.

### Are the Belgians Tiring?

There is some reason for congratulation in the accumulating evidence that continental makers are tiring of the reckless competition of the past few months. Merchants confessed in Birmingham this afternoon to a conviction that imported Belgian iron bars will be subject to an almost immediate rise of 5s., but English makers seemed rather more prepared to credit the forecast than buyers. There is certainly no rush to place orders at the present prices in anticipation of any rise.

### Gas-strip Association Meeting.

Conditions in the gas strip trade this week go to support the conviction recorded last week that the Makers' Association has closed its career. A further meeting is being held in Birmingham as this is written, and the market will be much surprised if the *coup de grace* is not there administered. Meantime prices have been reduced. Association houses were to-day quoting £6 7s. 6d. to £6 10s., but outside firms were selling at £6 5s., and in some cases even less.

### Galvanised Iron Exports.

Makers of galvanised sheets are not able to arrest the slump which set in just a few weeks ago, and all descriptions are marked down another 2s. 6d. per ton, prices now being quoted £10 15s. to £11 for export and £11 5s. (maximum) for the home trade. There is a falling off in the consumption both in the home and foreign trades. The first set-back to exporters came last month, when the quantity exported was 63,612 tons, compared with 67,914 tons in April, 1913. The values were £800,463 in April, 1914, and £922,894 in April, 1913. Almost all the principal markets shared in the reduced consumption, Australia alone registering a considerable advance. It is hoped the present decline in a most important Birmingham trade, which has for some time now been extending, is only temporary.

### Steel.

There is no material change in regard to steel. The slender margin of work in hand in the manufactured material department causes anxiety, but the principal works are running pretty regularly. The tendency as regards half-products is towards easier prices. Business has been done in billets and sheet bars as low as £4 10s. The more usual quotations are £4 12s. 6d. to £4 15s., with 2s. 6d. extra for Siemens. Considerable consignments of continental material are coming in at £4 5s.

# NOTES FROM LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

### Still Little Life in Pig Iron.

THERE was a fair, though not large, attendance on the Iron Exchange on Tuesday, but business was absolutely devoid of any interesting features. The Whitsuntide holidays already appear to be exercising an adverse influence upon business, and whilst trading in pig iron continues on the recent poor level, there is little or no quotable change to note in prices. The decrease in stocks of pig iron is, however, causing some concern, and it is expected that this will shortly have some effect on the market here. Finished iron and steel inactive, and copper quiet and unchanged. Sheet lead and English tin ingots also unchanged.

### Quotations.

Pig iron: Lincolnshire No. 3 foundry, 56s. 6d.; Staffordshire, 56s. 6d.; Derbyshire, 57s. to 57s. 6d.; Northamptonshire, 57s. 6d.; Middlesbrough, open brands, 60s. to 60s. 8d. Scotch (nominal): Gartsherrie, 68s. to 68s. 6d.; Glengarnock, 65s. 6d.; Eglinton, 64s.; Summerlee, 66s., delivered Manchester. West Coast hematite, 64s. 6d. to 65s.; East Coast ditto, 62s., both f.o.t. Delivered Heysham: Gartsherrie, 66s. to 66s. 6d.; Glengarnock, 63s. 6d.; Eglinton, 62s.; Summerlee, 64s. Delivered Preston: Gartsherrie, 67s. to 67s. 6d.; Glengarnock, 64s. 6d.; Eglinton, 63s.; Summerlee, 65s. Finished iron: Bars, £7 5s.; hoops, £7 12s. 6d. to £7 15s.; sheets, £8 7s. 6d. Steel: Bars, £6 7s. 6d. to £6 12s. 6d.; Lancashire hoops, £7 7s. 6d.; Staffordshire ditto, £7 17s. 6d. to £8; sheets, £9 to £9 5s.; boiler plates, £7 5s.; plates for tank, girder, and bridge work, £6 12s. 6d. to £6 15s.; English billets, £4 15s. to £4 17s. 6d.; foreign ditto, £4 5s. to £4 7s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, strips, &c., £78 per ton; small lots, 10d. per pound; rods, £77 per ton; small lots, 10d. per pound; tough ingots, £68 15s.; best selected, £68 15s. to £69 5s. per ton; copper tubes, 9½d.; solid drawn brass tubes, 7½d.; brazed brass tubes, 9¼d.; condenser tubes, 8¼d.; condenser plates, 7½d.; rolled brass, 7¼d.; brass turning rods, 6¼d.; brass wire, 7½d.; yellow metal, 7¼d. to 7½d. per pound. Sheet lead, £22 10s. per ton. English tin ingts, £155 per ton.

### The Lancashire Coal Trade.

There was again a moderate attendance on the Manchester Coal Exchange, and, taken all round, the tone ruled very slow. In house coal, although business continued of a limited character, some buyers operated to cover their requirements over Whit-week. Slack and engine fuel were offered in rather smaller quantity, but prices still favoured buyers. Shipping and bunkering coal were quiet. Quotations:—Best Lancashire house coal, 17s. 8d. to 18s. 10d.; good medium, 16s. 2d. to 17s.; domestic fuel, 13s. 5d. to 14s. 5d.; screened steam coal, 11s. 6d. to 13s.; slacks, 9s. to 10s. 9d. per ton at the pit.

### Manchester Steam Users' Association.

The fifty-ninth annual report of the Committee of Management of this Association was presented at a meeting of the members held at Manchester on Tuesday last. From this it appears that the number of boilers under inspection and the revenue for the year constituted a record in the Association's history. The number of members is 2138, and the number of boilers under inspection 10,079. As many as 9942 "internal," "flue," and entire examinations of boilers were made, the highest number ever attained. What is more important is the fact that no boiler in the Association's care burst during the year, and the Association is still able to claim that at the end of fifty-nine years no life has been lost from the explosion of any boiler which it has inspected and guaranteed as safe. In some of the boilers examined for enrolment defects were met with which, if not detected, would probably have led to serious consequences, showing the importance of competent independent inspection. Mr. Stromeyer, the Association's engineer, has recently designed a new electrically driven machine on which fatigue tests can be carried out on metals, both as regards torsion, bending, and push and pull stresses. Although the machine is not entirely new in principle, I understand, the design embraces features with which most engineers are unfamiliar. One of these is a calorimetric method of indicating the fatigue limit.

### Labour Dispute at Keighley.

An interesting case in connection with the strike in the engineering trade which has been on for some weeks at Keighley came before the Keighley magistrates on Tuesday last. A number of apprentices employed by a well-known firm of tool makers were summoned for breaking the terms of their apprenticeship indentures, and claims of £1 were made against the parents. From the statements of the prosecuting counsel it appears that the apprentices were responsible for organised disorder, which caused the masters to close down the works for some days. The works were re-opened again, but the apprentices again went out on strike without the consent of their employers, and the sureties were notified that unless the boys resumed legal proceedings would be taken. The chairman said that the employers were under an obligation to pay the apprentices their wages during the whole of their apprenticeship. It was true that the masters had failed to pay the wages during the strike, but the apprentices had their remedy. They were bound to attend their work, and the Bench was compelled to make an order requiring them to do so. They also made an order for the payment of £1 damages against the surety. Counsel for the defence asked that a case should be stated so that he might appeal, and this was granted.

### Cotton Trade Prospects.

Speaking at a meeting of the shareholders of the Fine Cotton Spinners' and Doublers' Association held in Manchester on Tuesday last, Lord Rotherham said that if the reckless building of cotton spinning mills such as was experienced seven or eight years ago could be avoided, he thought there was a very reasonable chance that the spinning branch of the industry should do reasonably well in the future, as the spinning and weaving branches of the industry seemed now pretty well balanced. Makers of textile machinery, especially that kind used in the spinning trade, will, however, be glad to hear that there are projects in existence for new mills.

### Manchester Tramways.

The annual report of the Tramways Committee of the Manchester Corporation states that in the year just ended 205,608,000 passengers were carried—an increase of 17 millions over the previous year. The average number of journeys per head of population per annum has risen from 201 to 218. The aggregate length of single track open for traffic is 194 miles 969 yards. The total revenue was £925,309, and the total expenses £585,223. The financial results per car-mile showed the revenue to be 11.410d., and the working expenses 7.216d.

BARROW-IN-FURNESS, Thursday.

### Hematites.

There is no change to note in the general condition of the hematite pig iron trade of this district. There is a heavy output of iron in all parts of North Lancashire and Cumberland, and this iron is going into prompt use. In the meantime makers are experiencing a fairly good demand for iron and orders are coming to hand. Prices are well maintained, with parcels of mixed numbers of Bessemer iron quoted at 66s. to 67s. per ton net f.o.b. For special brands of metal there is a steady request on home account, with 72s. to 74s. per ton net as the current rate. Nothing is being done in warrant iron, and the nominal quotation is 61s. per ton net cash. During next week the output of iron will be eased down somewhat owing to the holidays.

### Iron Ore.

The iron ore trade, on the whole, is well employed. There are not quite as many men working as was the case a few weeks ago, and some ore has been banked of late; but still a good business is being done and a huge tonnage of metal is being raised. For the highest grades of ore the demand is particularly brisk on local as well as general home account. Prices are maintainecd, with good average sorts at 13s. 6d. to 15s. 6d., and the best ores are up to 20s. 6d. per ton net at mines. Spanish ores are in steady request at 16s. to 17s. per ton delivered to West Coast works.

### Steel.

In the steel trade there is plenty of activity in most of the departments. The rail mills at Barrow are maintaining a good output of rails for home, colonial, and Indian buyers, and there is plenty of work in the plate mill. At the wire works there is also activity. In the Workington district the Moss Bay works are well employed and there is a busy state of affairs at the Derwent works on axles, &c. New business is plainly plentiful. For rails the inquiry is steady, with heavy sections at £5 17s. 6d. to £6 2s. 6d. per ton. Not much is being done in light sections, which are at £6 7s. 6d. per ton. At Barrow an order is in hand for heavy tram rails for Manchester and the current price is £6 7s. 6d. per ton. The demand for steel shipbuilding material is well maintained on local as well as general home account, and ship plates are at £6 10s. to £6 15s. per ton, and boiler plates are at £7 10s. to £7 15s. per ton. The hoop trade is steady, with the rate still at £8 5s. per ton.

### Shipbuilding and Engineering.

These trades present no new features. There is marked activity in every department, and this is likely to continue for some time. Next week only one day's holiday is being observed.

### Fuel.

The demand for coal is steady at 15s. 6d. to 17s. 6d. per ton for good steam sorts. East Coast coke is at 19s. to 22s.; Welsh coke at 20s.; and Lancashire qualities at 18s. per ton delivered.

# THE SHEFFIELD DISTRICT.

*(From our own Correspondent.)*

### General Conditions.

THE same feeling of uncertainty as to the immediate future of the iron and steel trades in this district appears to prevail, the past week having made little change in the situation. "There is no use concealing the fact," said one manufacturer to me a day or so ago, "trade is declining," but almost at the next turn you find a big steel works, largely employed in tramway material, very busy indeed. Firms whose activities are chiefly in the direction of industrial specialised work, and are not, therefore, so free to execute orders for anything and everything, are the people who are suffering most just now. There are many instances of real slackness and thin order books, but in well-informed circles a quite hopeful view is taken, there still being distinct possibilities of better things when home and foreign politics become more settled, which they must do sooner or later. Part of the lull at the moment is, of course, to be accounted for by the fact that the works here are on the eve of closing down for the Whitsuntide holiday, beside which the stock-taking period has arrived for very many firms, and for both reasons they are quite indisposed to increase stocks of raw material. One direction in which Sheffield is benefiting, and will do so for some time to come, is in departments connected with shipbuilding. There has been quite a revival of new orders, both for mercantile and Government work, and many of the requirements are met by Sheffield, from nuts and bolts to turbine drums and from gun turrets to wire for torpedo nets. Wire rope making appears to be in a fairly healthy condition, there being heavy demands for new colliery purposes particularly. It will, however, be another week or so before it can be definitely seen whether the present lull is passing or permanent, and in the meantime, as a manufacturer put it to me, this marking-time which the majority is experiencing is having a good effect in making firms look round and see where economies may be effected, for during the boom period too little attention was paid to unnecessary leakages.

### Round the Works.

New business which has come under my notice since last week includes large tonnages of steel for Yokohama, Calcutta, and Port Swettenham. The Madras and Southern Mahratta Railway has placed orders here with three firms for quantities of bolts, drills, and springs. Admiralty contracts have been received for rudder frames for destroyers being built at various yards, and for gun-metal valves and cocks for Devonport, Portsmouth, and Chatham. The New South Wales Government has ordered a large number of steel crossings, and for the Government of South Africa two firms are to make 200 bundles of railway links and a big lot of wheels and axles. For the New South Wales Government Hadfields, Limited, have, an order for about fifty heavy railway ramps, and the Agent-General for New Zealand has placed orders here for crank pins and spring steel. Edgar Allen and Co. have contracted to supply points and crossings for the Prahran and Malvern Tramways Trust, and for the Leeds Corporation John Brown and Co. are to make tires and Hadfields, Limited, tramway points. The London and South-Western Railway has given an order to a Sheffield firm for 1000 springs and locomotive tires.

### Pig Iron, &c.

Buyers of all kinds of raw material are holding severely off the market, except for small lots as required. A good many furnaces are either out or damped down, makers contending that it will pay them better thus to restrict output than to give way to consumers' demands for a lower level of prices, which they urge cannot be thought of until a quite appreciable fall occurs in coal prices. Generally speaking, therefore, values are firm in this district, for, though a slight reduction in the official prices of Lincolnshire No. 3 foundry is announced in Manchester, there is practically none of that class of iron used in Sheffield, the only business done here in Lincolnshire pig being a fair amount of forge and chiefly basic—that is, under normal conditions. Prices remain about as follows:—West Coast hematite, ordinary qualities, 73s. net; East Coast mixed numbers, 68s. net, Sheffield; Lincolnshire forge, 53s. 8d.; foundry, 54s. 8d. to 55s. 2d.; basic, 55s. 8d.; Derbyshire forge, 50s.; foundry, 54s. 6d. to 55s., delivered Sheffield. A considerable amount of cheaper pig iron is coming in to the district from places like Nottingham, the difference in price—about 2s. or 3s.—having rather a telling effect. Crown bars are doing very little better yet at the basis price of £7 5s., and hoops are quoted £7 12s. 6d. The general quotation for Siemens acid billets is £6 15s. to £7, with Bessemers about 5s. less. Hard basic is offered at £5 10s. and soft 15s. less, but both grades could probably be bought at a lower rate in face of the severe competition from the Continent. The market for all kinds of steel and iron scrap is very poor, especially as compared with two or three months ago, when some good business was done in steel sorts.

### Fuel.

There is no material change in the position of the steam coal market since a week ago, though, if anything, the tendency is weaker. The tonnage going for shipment is still small compared with a year ago, and, whilst a substantial increase in this department is anticipated after the holidays, it is doubtful if values will be affected to any appreciable extent. Forward business is practically at a standstill, buyers persistently holding off the market, and even though collieries are far more inclined to meet buyers on the question of prices than they were a short time ago, the amount of forward business arranged is much less than usual. The demand for industrial consumption is steadily declining, the greatest activity being in the heavy armament departments. Many works will set down for about a week over the holidays for stock-taking and repairs to machinery, and collieries will stand for three or four days. In the smaller fuels the position is decidedly easier. Many collieries have considerable stocks on hand, special lots being offered at lower figures. Current quotations are, per ton at pits, as follows:—Best South Yorkshire hards, 11s. to 11s. 3d.; best Derbyshire, 10s. 6d. to 11s.; second quality, 9s. 6d. to 10s.; steam cobbles, 9s. 6d. to 10s. Coke is as weak as ever, the demand being a long way behind the supply and as low as 9s. 6d. is stated to have been accepted, though the ordinary price is 1s. or 1s. 6d. higher.

# NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Cleveland Iron Trade.

THE outstanding feature of the Cleveland iron trade is the continued scarcity of free iron. Makers have practically no stocks, while the depletion of the public store at a high rate continues. Consumers, however, are acting with much caution in their dealings, as there is a feeling of uncertainty with regard to the future. In the circumstances, notwithstanding the general dulness of trade, prices are steadily held, and there is no disposition on the part of makers to give way. The iron made is going steadily into consumption, and makers have no occasion to press sales on the market. They would be glad to see their order books for the second half of the year in a healthier condition, but with prices at their present level there is no inducement to trade, and they are reluctant to commit themselves far ahead. The position, however, is not altogether unsatisfactory. There are sufficient orders in hand, and they are content to go on and await the revival which must come with the autumn buying. It is a significant indication of the trend of events that the public store now contains no other brand of iron than No. 3 Cleveland, and that is rapidly diminishing. For a long time there has appeared an item of 43 tons of "other iron deliverable as standard"—in reality, No. 4 foundry—but that has now been withdrawn. The general market quotation for No. 3 G.M.B. Cleveland pig iron is 51s. 6d., but consumers are not prepared to pay more than 51s. 4½d. No. 1

is 53s. 10½d. to 54s.; No. 4 foundry, 51s. 3d.; No. 4 forge, 50s. 9d.; and mottled and white iron each 50s. 3d.—all for either early or forward delivery.

**Hematite Pig Iron.**

The hematite pig iron trade is feeling the effects of the slackness in finished iron and steel. Business on the market has been of a very meagre description during the week. Consumers are only purchasing against immediate requirements, and the amount of new business is small. Of late the consumption of hematite by steel makers has not been so heavy, and unless trade improves the production will be curtailed. The general market quotation for mixed numbers of East Coast hematite is 61s. for either early or forward delivery.

**Iron-making Materials.**

The foreign ore trade is affected on the one hand by the slackness in hematite, and, on the other, by the heavier Bilbao freights. Indications, however, are not wanting of the approach of some movement. Ore is not now coming forward as it did and consumers, though still well placed, are beginning to consider the necessity of renewing contracts. The price—17s. 6d. for best Bilbao Rubio—is held to be too high, but substantial business would, no doubt, induce reasonable concessions. Some cargoes of silicious ore have been sold, though the price was not announced. Coke is scarce, and there has been some pressure for deliveries in view of the holidays. Prices are very stiff, and good medium furnace kinds of Durham make are not obtainable below 17s. 3d.. delivered at the works.

**Manufactured Iron and Steel.**

There is very little fresh to report concerning the manufactured iron and steel trades. While specifications are still coming in locally fairly well, new business is exceedingly quiet. Meanwhile steel makers are well employed, and confidently anticipate a steady trade and a better demand in the near future. A revival of inquiries and orders usually manifests itself early in June in order to cover requirements over the second half of the year, and the lower prices now in force should stimulate the volume of new work. The finished iron trade has not been so unequal for the past three years. Cases of activity and depression are to be found side by side. The following are the principal market quotations:—Common iron bars, £7; best bars, £7 7s. 6d.; best best bars, £7 15s.; packing iron, £6 5s.; iron ship angles, £7; iron engineering angles, £7; iron ship plates, £6 15s.; iron girder plates, £7 5s.; iron ship and girder rivets, £7 5s.; steel bars, basic, £6 5s.; steel bars, Siemens, £6 15s.; steel ship plates, £6 7s. 6d. to £6 10s.; steel boiler plates, £7 10s.; steel ship angles, £6 2s. 6d. to £6 7s. 6d.; steel engineering angles, £6 17s. 6d. to £7; steel sheets, singles, £8 5s.; steel sheets, doubles, £8 10s.; steel joists, £6 12s. 6d.; steel hoops, £6 10s.; steel strip, £6 5s.—all less the usual 2½ per cent. f.o.t. Heavy steel rails, £6; steel railway sleepers, £7 5s.; light iron rails, £7—all net at works. Cast iron chairs, £4 5s.; cast iron pipes, 1¼in. to 2in., £6 7s. 6d.; 3in. to 4in., £6; 5in. to 8in., £5 15s.; 10in. to 16in., £5 17s. 6d.; 18in. to 24in., £5 17s. 6d.; cast iron columns, plain, £7 7s. 6d.; floor plates, £3 10s. to £3 12s. 6d.—f.o.r. at makers' works. Demand in the galvanised sheet trade remains sluggish. The general quotation for sheets of 24 gauge is £11 5s. per ton, less the usual 4 per cent., but consumers are holding out for a lower rate.

**Shipbuilding and Engineering.**

Whatever the prospects elsewhere may be, there is no possibility of a serious slump in the shipbuilding industry on the North-East Coast for a long time to come. To work off existing contracts and orders will take at least eighteen months, and as additional tonnage is being arranged for from time to time, the trade position is very healthy. The Tyne has done exceedingly well in the competition for work under the British naval programme for the current year. In 1913, it will be remembered, the Tyne secured the greater share of the Admiralty contracts, and on the present occasion, when two battleships were given out, one has come to the Palmer Company at Jarrow. The firm has a very busy period ahead of it in naval work, and very soon there will be the uncommon spectacle at Jarrow shipyard of two Dreadnoughts being built at one time. A similar thing has not happened since the year 1893, when the battleships Resolution and Revenge were built, and it is a curious fact that on the next occasion, when the firm is entrusted with the building of two battleships at the same time, one of the vessels should be named Resolution. The estimated cost of the Resolution, which is now in frames, and which will take another eighteen months to complete, is about £2,225,000. The new ship to be laid down—the Repulse—will be of a similar class. She will have a displacement of 25,500 tons, and a speed of 21½ knots, and her armament will consist of eight 15in. guns and very likely sixteen 6in. guns. Orders for three cargo steamers have been placed this week with Northern builders. There is also a large amount of work in progress in the general engineering branches.

**Coal and Coke.**

The position of the coal trade continues to be very satisfactory, and prices as a rule are well maintained. Collieries are reported to have their order books well filled, so there is not much likelihood of any immediate reduction in prices. For June shipment there is a good demand for all descriptions, and sellers hold strongly. Durham gas coals are very firm, and are likely to maintain their position for some time. Best qualities of Durham gas coal are quoted at 13s. 3d. to 13s. 6d., and seconds about 12s. 6d. The bunker coal trade is fairly active, and best qualities command 12s. 9d. to 13s., and ordinaries 11s. 6d. to 12s. Best steams are firm at 14s. 3d. to 14s. 6d. There is a continuance of steady demand for coke, and prices are firm at 13s. 6d. to 13s. 9d. for gas coke, 19s. to 20s. for foundry and 17s. 6d. for furnace coke.

## NOTES FROM SCOTLAND.

*(From our own Correspondent.)*

**The Warrant Market.**

Owing to the holiday in Glasgow the market was only open for four days and the total turnover only amounted to 5000 tons. At the outset prices were firmer, but dropped latterly to 51s. and closed at 51s. 2d. per ton cash buyers, showing a loss of 4d. per ton on the week. There have been further withdrawals from stores to the extent of 2904 tons, and the total quantity in store is now 89,030 tons, compared with 237,097 tons in the corresponding week of last year.

**Pig Iron.**

Nothing of special interest has occurred in the Scotch pig iron trade since last week. Inquiries for ordinary qualities for export are a trifle better, but the demand for home consumption is weak and makers are not increasing their engagements to any great extent. It is reported that business has been done in Scotch hematite at 82s. 6d. per ton.

**Quotations.**

Prices of Scotch makers' iron are unchanged, and are as follows:—Monkland is quoted f.n.s. at Glasgow, No. 1, 62s.; No. 3, 60s. 6d.; Govan, No. 1, 61s.; No. 3, 60s.; Carnbroe, No. 1, 66s. 6d.; No. 3, 62s. 6d.; Clyde, No. 1, 68s.; No. 3, 63s.; Gartsherrie, Summerlee, Calder, and Langloan, Nos. 1, 68s. 6d.; Nos. 3, 63s. 6d.; Glengarnock, at Ardrossan, No. 1, 71s.; No. 3, 66s.; Eglinton, at Ardrossan or Troon, No. 1, 62.; No. 3, 61s.; Dalmellington, at Ayr, No. 1, 63s.; No. 3, 61s.; Shotts, at Leith, No. 1, 68s. 6d.; No. 3, 63s. 6d.; Carron, at Grangemouth, No. 1, 69s.; No. 3, 64s. per ton.

**Scotch Steel Trade.**

There is no change in the position of the Scotch steel trade, and although makers in some cases have quoted prices reduced from 2s. 6d. to 5s. per ton, this has had no apparent effect on the volume of business. Specifications for plates continue scarce and mills are poorly employed. The export inquiry is also quiet and conditions generally leave little room for encouragement. A conference was held in Glasgow during the week between representatives of the steel makers and their employés for the purpose of discussing an application by the workers for an increase of 25 per cent. in their wages. The men offered to submit the matter to arbitration, but the employers could not accept this offer until they had consulted their association—the North of England Steel Ingot Association. The men agreed to an adjournment on condition that the employers' intimated their decision in three weeks' time.

**Finished Iron.**

The outlook in the finished iron trades is, if anything, less encouraging than ever. Black sheet makers are just managing to keep their plants occupied with orders booked from day to day, and while outputs are still fairly satisfactory, makers cannot see any distance ahead, although some of them are willing to contract forward at current prices. The malleable iron trade continues in a very depressed condition, and there are as yet no signs of relief; in fact, on the contrary, it appears to be deepening. Most of the works are experiencing great difficulty in running seven shifts per week, which is the maximum allowed by the association. Foreign material is still being imported in large quantities, and until home makers are in a position to compete successfully against foreign prices there is little prospect of an improvement.

**Coal Trade.**

While the position of the trade in the West of Scotland cannot be called satisfactory, collieries in the Lothians and Fifeshire are actively employed. In the western district the chief feature is the demand for splint. Ell coals are disappointing, and in most cases buying is postponed until the last moment in this class. Other grades are weak and prices show a declining tendency. In the East there is a good shipping demand and a good supply of tonnage at the Fifeshire ports. Navigation coals are in good demand and first-class steams are full up at the moment, while third-class qualities are also busy.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

**Cardiff Coal Trade.**

Operations on current account have been on rather narrow lines during the past week. The approach of the Whitsuntide holidays has to some extent made itself felt in that a rather quieter tone has become manifest. The tonnage question has adversely affected some collieries, compelling them to accept lower figures for spot shipment in order to provide empties and keep pits working, but for forward shipment a stronger tone is displayed. Owing to the fact that outputs will be considerably curtailed next week, the official holidays of the miners embracing Monday, Tuesday, and Wednesday, buyers have shown more eagerness to fix up their requirements for June, and, as a matter of fact, several of the leading collieries report very full order books and are asking 1s. and even more in advance of the current top price for next month's loading. Such prices, however, are not being paid to any appreciable extent; still sellers are in such a position in many instances as to enable them to hold out for their own price. The outlook for the whole of the summer looks fairly promising, inasmuch as with increased leave-taking on the part of the men, resulting in restricted production, and contract business continuing to come in, the probabilities are that a good market will be maintained. About 30,000 tons of leading Admiralties on account of the Turkish navy have been bought, and a similar quantity for the Greeks, while the Paris-Orleans Railway is in the market for a supplementary quantity of about 10,000 tons of large steams and the Bulgarian Railways for 10,000 tons of locomotive coals. House coals and other bituminous sorts, patent fuel, and cokes have shown little change.

**Approximate Quotations.**

Steam coal: Best Admiralty, large, 19s. 6d. to 20s.; best seconds, 18s. 6d. to 19s.; seconds, 17s. 9d. to 18s. 3d.; ordinaries, 17s. to 17s. 6d.; best drys, 18s. 3d. to 18s. 6d.; ordinary drys, 16s. to 16s. 9d.; best bunker smalls, 11s. to 11s.6d.; best ordinaries, 10s. 3d. to 10s. 6d.; cargo smalls, 7s. 9d. to 8s. 6d.; inferiors, 7s. to 7s. 9d.; washed smalls, 12s. to 12s. 6d.; best Monmouthshire black vein, large, 17s. to 17s. 6d.; ordinary Western Valleys, 16s. 6d. to 17s.; best Eastern Valleys, 15s. 6d. to 16s.; seconds, Eastern Valleys, 15s. to 15s. 3d. Bituminous coal: Best households, 19s. to 20s.; good households, 17s. to 19s.; No. 3 Rhondda, large, 17s. 6d. to 18s.; smalls, 12s. to 12s. 6d.; No. 2 Rhondda, large, 13s. to 13s. 6d.; through, 11s. 6d. to 12s. 6d.; smalls, 9s. to 9s. 6d.; best washed nuts, 16s. to 16s. 6d.; seconds, 14s. 6d. to 15s. 3d.; best washed peas, 14s. 6d. to 15s.; seconds, 13s. 6d. to 13s. 9d. Patent fuel, 19s. to 21s. 6d. Coke: Special foundry, 28s. to 29s.; good foundry, 22s. to 25s.; furnace, 17s. to 19s. Pitwood, ex ship, 21s. 3d. to 21s. 9d.

**Newport (Mon.).**

Extremely little variation in the value of Monmouthshire coals has been shown during the past week. Irregularity for shipment before the holidays has been fairly pronounced owing to the fact that tonnage supplies have been below the normal quantity. For loading after the holidays a very steady tone is shown, but generally speaking the market has been rather featureless. Approximate values:—Steam coal: Best Newport black vein, large, 17s. to 17s. 6d.; Western Valleys, 16s. 6d. to 17s.; Eastern Valleys, 16s. to 16s. 6d.; other sorts, 15s. 3d. to 15s. 6d.; best smalls, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s. Bituminous coal: Best house, 18s. to 19s.; seconds, 17s. to 18s. Patent fuel, 19s. 6d. to 20s. 6d. Pitwood, ex ship, 21s. 3d. to 21s. 9d.

**Swansea.**

A rather steadier tone has been displayed recently in anthracite coals. Chartering has improved, but still the market lacks real strength, and the inquiry taken all round is somewhat slow. The market is on the easy side for early delivery. A very moderate demand has been shown for machine-made descriptions, but rubbly culm continues to be very firmly quoted, duff being steady. No particular change has been displayed in the steam coal section, large being quiet. Approximate prices:—Anthracite: Best malting, large, 21s. 6d. to 23s. net; second malting, large, 17s. 9d. to 19s. net; big vein, large, 16s. to 17s., less 2½ per cent.; red vein, large, 12s. 9d. to 13s. 6d., less 2½ per cent.; machine-made cobbles, 21s. to 22s. net; French nuts, 21s. 9d. to 23s. 9d. net; German nuts, 21s. 9d. to 23s. 6d. net; beans, 15s. 9d. to 17s. 3d. net; machine-made large peas, 10s. 9d. to 12s. net; rubbly culm, 6s. 3d. to 6s. 9d., less 2½ per cent.; duff, 4s. 6d. to 4s. 9d. net. Steam coal: Best large, 18s. 6d. to 20s. 3d., less 2½ per cent.; seconds, 14s. 6d. to 15s. 6d., less 2½ per cent.; bunkers, 11s. to 12s., less 2½ per cent.; smalls, 8s. 3d. to 9s., less 2½ per cent. Bituminous coal: No. 3 Rhondda large, 17s. to 18s., less 2½ per cent.; through and through, 14s. 3d. to 15s., less 2½ per cent.; smalls, 11s. to 11s. 9d., less 2½ per cent. Patent fuel, 17s. to 17s. 6d., less 2½ per cent.

**Iron and Steel Trades.**

Pig iron: Standard iron, 50s. 9d. cash, 50s. 10d. month; hematite mixed numbers, 61s. cash, 61s. 1d. month; Middlesbrough, 51s. 1d. cash, 51s. 2d. month; Scotch, 57s. 1½d. cash, 57s. 2½d. month; Welsh hematite, 65s. dd.; East Coast hematite, 64s. c.i.f.; West Coast hematite, 66s. to 67s. c.i.f. Steel bars: Siemens, £4 11s. 3d. per ton; Bessemer, £4 10s. per ton. Steel rails, heavy sections, £6 15s. Iron ore: Rubio, 17s. 3d. to 17s. 6d.

**Tin-plate and Other Quotations.**

I.C., 20 × 14 × 112 sheets, 12s. 6d. to 12s. 7½d.; I.C., 28 × 20 × 56 sheets, 12s. 9d. to 12s. 10½d.; I.C., 28 × 20 × 112 sheets, 25s. 3d.; I.C. ternes, 28 × 20 × 112 sheets, 22s. 3d. to 22s. 6d. Finished black plates, £9 10s. per ton. Galvanised sheets, 24 g., £10 15s. to £11 per ton. Block tin, £149 15s. per ton cash, £151 15s. per ton three months. Copper, £63 3s. 9d. per ton cash, £63 16s. 3d. per ton three months. Lead: English, £19 per ton; Spanish, £18 15s. per ton. Spelter, £21 7s. 6d. per ton. Silver, 25⅛d. per oz.

## CATALOGUES.

Ozonair Limited, 96, Victoria-street, S.W.—This firm has sent us a catalogue dealing with Ozonair apparatus for general purposes.

A new pamphlet forwarded by the Power Plant Company, Limited, of West Drayton, Middlesex, deals with electric hand milling, tapping, and reaming machines.

The Dudbridge Ironworks, Limited, Stroud, Gloucestershire.—A well got up catalogue dealing with variable admission gas engines and gas producing plants has reached us.

Babcock and Wilcox, Limited, Oriel House, Farringdon-street, E.C.—A new illustrated catalogue from this firm deals with patented davits, and sets forth very clearly the advantages and underlying principle.

A. Borsig, Tegel (London agent, 22, Martin's-lane, Cannon street, E.C.).—A small pamphlet, forwarded to us by this firm, deals with automatic water supply for domestic purposes by means of the Crystal centrifugal pump. The system is fully described and prices and other particulars of interest to buyers given.

Agreement in the Shipbuilding Industry.—An arrangement has just been concluded whereby an exchange of shares is effected and a community of interests ensured between the firms of Swan, Hunter and Wigham Richardson, Limited, of Wallsend and Walker-on-Tyne, and H. and C. Grayson, Limited, of Liverpool and Birkenhead. The Tyneside works of Swan, Hunter and Wigham Richardson, Limited, cover seventy-eight acres, and include shipyards at Wallsend and Walker, the Neptune Engine and Boiler Works at Walker, and the dry docks department at Wallsend, comprising two graving docks and two floating docks. Last year this firm effected an exchange of shares with Barclay, Curle and Co., Limited, shipbuilders and engineers, of Whiteinch, Glasgow, whose works include the Clydeholm Shipyard, at Whiteinch, the Stobeross Engine and Boiler Works, Glasgow, the Clydeside Repairing Works at Govan, and the Elderslie shipyard and graving dock at Scotstoun West. Swan, Hunter and Wigham Richardson, Limited, also have a large interest in the Wallsend Slipway and Engineering Company, Limited, of Wallsend, and in Harris Brothers, Limited, owners of the two Cambrian dry docks at Swansea. H. and C. Grayson, Limited, is one of the oldest firms of the kind in the country, its business dating as far back as 1765. It owns graving docks, slipways and repairing works at Liverpool, Garston and Birkenhead. The management of the three businesses at Wallsend, Liverpool and Whiteinch remains the same as before.

Napier Tercentenary Celebration.—On July 24th to 27th next there will be held a celebration, under the auspices of the Royal Society of Edinburgh, of the tercentenary of the publication of Napier's "Mirifici Logarithmorum Canonis Descriptio," the work which embodies the discovery of logarithms. Lord Moulton, F.R.S., will deliver the presidential address on July 24th, and many distinguished mathematicians, astronomers, actuaries, and engineers will make communications on July 25th and 27th. An exhibition of calculating machines, apparatus, and books, and of objects associated with Napier and the history of mathematics, will be held in connection with the celebration. Immediately following the Napier celebration a mathematical colloquium will be held on July 28th to 31st, under the auspices of the Edinburgh Mathematical Society. The following courses of lectures have been arranged for in connection with the colloquium:—Two lectures by M. d'Ocagne, Professor à l'Ecole Polytechnique, Paris, on "Nomography." Four lectures by Mr. H. W. Richmond, F.R.S., Fellow and Lecturer of King's College, Cambridge, and University Lecturer on Mathematics, on "Infinity in Geometry." Four lectures by Mr. E. Cunningham, Fellow and Lecturer of St. John's College, Cambridge, on "Critical Studies of Modern Electric Theories." Two lectures by Dr. E. T. Whittaker, F.R.S., Professor of Mathematics in the University of Edinburgh, on "The Solution of Algebraic and Transcendental Equations in the Mathematical Laboratory." Those who desire to become members of either the celebration or the colloquium, or both, may obtain particulars from Mr. P. Comrie, 19, Craighouse-terrace, Edinburgh.

The Institution of Municipal and County Engineers.—A meeting of the Institution will be held in the Scottish District at Dunfermline, Friday and Saturday, the 5th and 6th June. Friday:—In Court Room, City Chambers, Dunfermline, at 11 a.m. 2 p.m.: Discussion on the following papers:—"A Town Planning Scheme: Its Effects on Housing and Architecture," by Mr. Raymond Unwin. "Early Examples of Town Planning in the City of Edinburgh," by Mr. A. Horsburgh Campbell. "Town Planning from a Lawyer's Point of View," by Mr. John L. Jack. "The Advantages of Steam Tractor Haulage over Team Labour for Road Metal," by Mr. W. L. Gibson. Municipal works to be visited:—(1) Visit to main outfall sewer (tunnel work). Leave at 4.30 p.m., arriving back at 6.45 p.m. Tickets 1s. 6d. (2) Inspection of town planning maps in City Chambers. (3) Visit to Pittencrieff Glen and Museum. 7.30 p.m.: Annual dinner. Saturday:—Visit to Naval Base, Rosyth. Motor chars-à-bancs will leave the City Chambers at 9.15 a.m. prompt, arriving back at Dunfermline at 1.30 p.m., where lunch will be provided. Permission to visit Rosyth has been granted on the following conditions, which must be strictly observed:—(1) Each member of the party must be a British subject. (2) Photographs are not allowed to be taken. (3) No claim of any kind is to be preferred against either the Admiralty or the contractors for any accident which may occur on the works to any member of the party. (4) No account of the works is to be published. (5) The visit is to be made in the morning so as to leave the works before 1 p.m. Visit to Carnegie Institutions:—2.45 p.m.: Baths; Gymnasium Women's Institute; Clinique. 4.30 p.m.: Tea in Pittencrieff Glen, kindly provided by the Carnegie Dunfermline Trustees.

## NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

*(From our own Correspondent.)*

### Rheinland-Westphalia.

THERE is hardly any change to report in connection with the iron and steel industry. If some bar mills have been able to obtain M.1 and M.2 p.t. more than was given a few weeks ago, there are also a good many establishments that can hardly maintain the former rates. The building department lacks animation, and very few orders of any weight can be secured. Much reserve is shown in all branches of the iron and steel trade, and underquoting is the order of the day. The prices for pipes have again been reduced, but this has not in any way influenced demand, which is stated to be rather below the average.

### Iron and Steel in Silesia.

What has been said above of the Rhenish-Westphalian iron industry also holds good for the Silesian market. Buying is still reduced to the utmost, for consumers and dealers evidently expect prices to move further downwards, and the few contracts on offer are keenly competed for by the Western districts, which have been trying with all their might for some time past to find a market for their production in Silesia. The bar and plate department is, if possible, even more neglected than other branches, employment being irregular and frequently insufficient, while stocks are heavy and increasing. Satisfactory occupation is reported from the rail mills, and prices may be considered remunerative. Girders, though still in somewhat moderate request, have shown a slight improvement during the past few weeks, while the position of the pipe industry continues unsatisfactory. Exports of Silesian iron to Austria-Hungary and to the Balkan districts have ceased almost entirely, and with Russia only a very limited business is being done, the Silesian firms being unable to beat their English rivals, especially in Central Russia.

### List Quotations.

The following are the current rates per ton, free at works:—Raw spathose iron ore, M.12.60; roasted ditto, M.19; Nassau red iron ore, 50 per cent. contents, M.14 p.t.; spiegeleisen, 10 to 12 per cent. grade, M.79; white forge pig, M.66; iron for steel making, Rhenish-Westphalian, and Siegerland brands, M.69 to M.70; German Bessemer, M.79.50; Luxemburg foundry pig, No. 3, M.60 to M.62; German foundry pig, No. 1, M.75.50; the same, No. 3, M.70.50; German hematite, M.79.50; good merchant bars, common quality, M.94 to M.96; basic hoops, M.115 to M.120; heavy basic plates, M.99 to M.102; steel plates for boilermaking purposes, M.109 to M.112; sheets, M.115 to M.120; drawn iron or steel wire, M.117.50.

### The German Coal Market.

In Silesia a very moderate trade has been done in engine and house fuel during this and the past week. Export is quiet. In coke, consumption is stated to be considerably behind production, and a restriction of 15 per cent. in output is contemplated by the Upper Silesian Coal Convention. In the Rhenish-Westphalian coal district a fair amount of life is being shown, demand having improved after the April reductions in price.

### Austria-Hungary.

The expectations of an improvement in demand or prices still remain unfulfilled. A most limited business has been done during the past few weeks. There is a waiting attitude all round, and the outlook seems uncertain. Current prices are as follows:—Foundry pig, No. 1, 99 crowns; No. 3, 97 crowns; hematite, No. 1, 115 crowns; No. 2, 113 crowns; charcoal pig iron, 130 crowns; white forge pig, 110 crowns; spiegeleisen, 10 to 12 per cent. grade, 150 crowns; steel iron, 113 to 115 crowns, all per ton free Vienna. Both pit coal and brown coal show a quiet tendency.

### No Improvement in Belgium.

Prices have become easier again for some sorts of manufactured iron. Both demand and inquiry have decreased, and the situation all round is anything but favourable. Export prices are decreasing from week to week, and reductions in output are the order of the day. The weakening tendency in quotations induces consumers to hold back with their orders more than ever before. They are awaiting further reductions, and only a very small number of contracts has been placed recently. Pig iron meets with a limited demand. Of sixty existing furnaces fifty only are in blast now, with a daily output of 7193 t., while in May last year fifty-two were in blast out of fifty-five existing. Production of pig iron in Belgium during the first four months this year was 814,030 t., as compared with 846,170 t. in the corresponding period in 1913. Semi-finished steel has shown symptoms of increasing weakness, 70s. p.t. being quoted, f.o.b. Antwerp. Inland as well as overseas orders for rails come in slowly, while in girders more life is reported. Plates are neglected as before; heavy plates of 5 mm. and more have gone down to £4 13s. p.t.; the ¼in. sorts stand at £4 16s. p.t., and for medium sorts the export prices are 1s. and 2s. p.t. lower than the German offers. The unsettled condition of the bar trade is increased by fierce competition. Basic bars are obtainable at £4 p.t. Export prices for iron bars are £4 6s. and £4 7s. p.t. Hoops are in moderate demand, and are maintained at £4 16s. p.t. for export. Consumption of engine coal has been decreasing, and coke is also in slow request

## AMERICAN NOTES.

*(From our own Correspondent.)*

NEW YORK, May 13th.

THE one most interesting feature of the steel trade is the increasing number of small orders for structural material for small building operations. Last week's volume of business was larger than in any week for two months in structural steel. The Vanderbilt building in this city takes 2000 tons, and a Southern railroad 2500 tons. The Erie has ordered 12,000 tons of rails, and other roads swell the volume up to nearly 35,000 tons. Production of pig iron for April 2,361,601 tons, and 20 furnaces were blown out. Some 1100 tons of Nova Scotia iron were landed last week, but at slight profit. A little more activity is noted in pig iron, though demand is below normal. The furnace interests are not seeking business, and buyers are ordering from hand to mouth. Conditions appear to be ripening for a general improvement in the early summer. One favourable sign is that almost all consumers of crude iron have nothing on hand, where ordinarily they carry liberal supplies. This is true of most finished material. The warehouses are almost empty. Jobbers order only as they receive orders. There is quite a volume of general construction work in hand calling for structural material. It will require very little more confidence to start a general buying movement all along the line, but while present underlying conditions prevail buying will be limited to actual necessities. Exports of copper for the first seven days of May, 6430 tons; total since January 1st, 157,842 tons. Increase of surplus copper for April, 5,727,682 lb. Domestic consumption decreased during April 6,424,000 lb., and exports decreased 7,216,000 lb., although the output reached 151,500,531 lb. Electrolytic sagged to 14¼, at which price an improving demand is looked for, especially as domestic consumers are slow buyers.

## BRITISH PATENT SPECIFICATIONS.

*When an invention is communicated from abroad the name and address of the Communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 8d. each.*

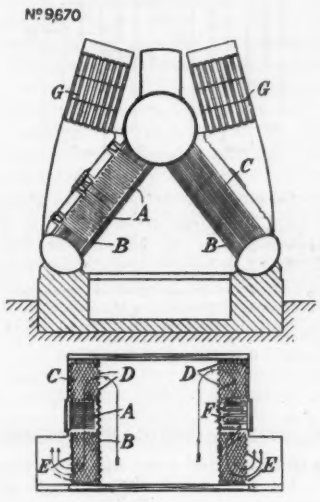
*The date first given is the date of application: the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete Specification.*

*Any person may, on any of the grounds mentioned in the Act, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of any Patent.*

### STEAM GENERATORS.

9670. April 24th, 1913.—WATER-TUBE BOILER, Vulcan-Werke, Hamburg und Stettin Actiengesellschaft, Hamburg 9, Germany.

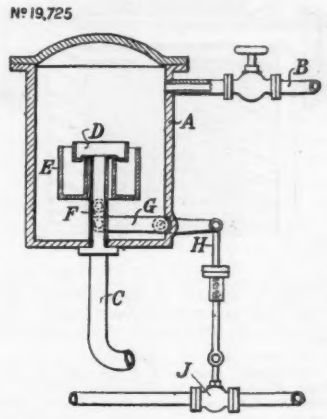
This is a marine boiler provided with superheating elements. These elements consist of coils A arranged in a vertical plane, and are disposed among the ordinary water tubes by omitting a certain number of the latter. The inner and outer walls B C




of the water-tube nests are formed of closely spaced tubes presenting a continuous surface except at D E, where spaces are left for the ingress and egress of the furnace gases. If desired, the superheater portion can be subdivided by interposing walls of tubes between the coils as shown at F. G is an air heater.—*May 6th*, 1914.

19,725. September 1st, 1913.—FEED-WATER REGULATOR. J. McCallum, 16, Calderwood-road, Newlands, Glasgow.

A vessel A is connected by a pipe B with the steam space of the boiler, and by a pipe C to the water space. The pipe C projects inside the vessel and is provided with a perforated top piece D. Surrounding the end of the pipe C is a container E

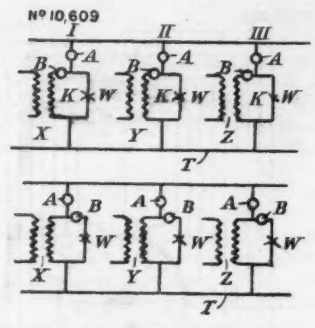



linked at F to a lever G. This lever outside the vessel is connected by a rod H with a balanced check valve J on the feed-water main. When the feed-water overflows into the container it brings about the closure of the check valve. This valve will open again when evaporation has proceeded sufficiently to lower the water level in the boiler and in the container E.—*May 6th*, 1914.

### DYNAMOS AND MOTORS.

10,609. May 5th, 1913.—A DEVICE FOR THE AUTOMATIC MAINTENANCE OF PHASE EQUALITY OF THE CURRENTS OF PARALLEL-CONNECTED ALTERNATING-CURRENT MACHINES, Allgemeine Elektricitäts-Gesellschaft, of Friedrich Karl-Ufer 2–4, Berlin, Germany.

This specification describes a device for the automatic maintenance of phase equality of the currents of parallel-connected alternating-current machines, in which for each machine phase-indicating instruments are provided which are used for the purpose of acting upon the excitation of the corresponding machines. There are in all twelve illustrations, and the two we have reproduced show two out of the twelve alternative arrangements. So long as the phase responsive instruments have a torque the effort that is exerted to influence the excitation of the corresponding machines is utilised in such a sense that the compensating current between the parallel-connected machine disappears, that is to say, the parallel-connected alternating-current machines are again equalised to a coinciding current phase. The torque in the phase responsive instruments can, of course, only exist when their two coil systems are traversed simultaneously by current, and these two currents have phases which differ one from the other. In corresponding phases of the individual machines—themselves not shown but indicated by the numbers I., II., III.—are inserted in well-known manner the current transformers X Y Z. Each of the secondary wind ings of these current transformers is connected to resistances W, closed upon a circuit K and are connected in parallel by equalising lines T. A phase responsive instrument is used for each machine, and each is furnished with two coil systems, of which one, A, is connected in one of the

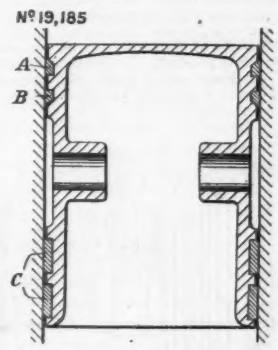



connecting lines to the equalising wires, while the second coil system B is connected in the circuit K at any desired point. In the arrangement of connections represented in the upper diagram the coil systems B are connected between the secondary winding of the transformer and one of the connecting wires leading to the upper equalising line, while in the arrangement shown in the lower illustration the coil systems B are connected in series with the resistances W in the manner shown on the right of the cables I., II., III.—*May 6th*, 1914.

### INTERNAL COMBUSTION ENGINES.

19,185. August 23rd, 1913.—PISTON, Vickers Limited, Vickers House, Broadway, Westminster, London, and another.

The object of this invention is to overcome the wear arising from the tilting of the piston around its gudgeon pin when the crank of the engine passes over a dead centre. It consists

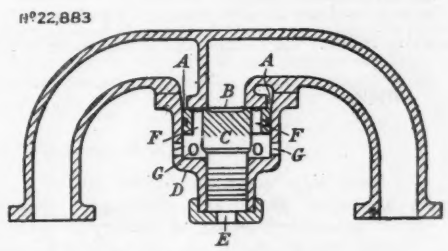



in providing the piston with two piston rings A B and two guide rings C. These two sets of rings, being on opposite sides of the gudgeon pin, are claimed effectively to stay the piston and prevent it tilting. The rings A B are tapered as shown. The ring A expands on the explosion stroke and the ring B on the compression stroke.—*May 6th*, 1914.

### LOCOMOTIVES.

22,883. October 10th, 1913.—MEANS FOR PUTTING LOCOMOTIVE CYLINDER ENDS INTO COMMUNICATION WITH EACH OTHER AND WITH THE ATMOSPHERE, W. Adamson, 17, Somerville-drive, Mount Florida, Glasgow.

This device is intended to act as a combined by-pass valve, snifting valve, and release valve. It consists of a curved pipe with two central and concentric circular openings A B. The ends of the pipe are connected to the ends of the cylinder. The annular opening A is thus in communication with one end of




the cylinder and the circular opening B with the other. Both are normally closed by a valve C contained in a casing D, to which steam from the cylinder valve chest is admitted at E. The valve C is provided with passages at F and the casing D with holes at G. When steam is shut off at the regulator the valve C drops and the two ends of the cylinder are put into communication with one another and with the atmosphere through the ports F G.—*May 6th*, 1914.

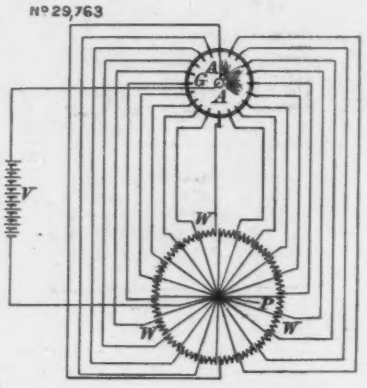
### RECTIFIERS.

29,763. December 24th, 1913.—IMPROVED RECTIFIER FOR ALTERNATING POLYPHASE CURRENTS, *Siemens Schuckert Werke G.m.b.H., of Askanischer Platz 3, Berlin, S.W.*

The direct-current load is represented by the battery of accumulators V, one terminal of which is connected with the mercury of the rectifier G and the other terminal with the neutral point P of the secondary winding of a rotary field transformer. The secondary winding is divided into as many parts as may be required, and each part W is connected at one end to the neutral point P and at the other end to one of the electrodes A of the rectifier. For every part into which the winding is divided there is a corresponding electrode A. The primary winding, which may be open or closed, is inductively connected with the

different parts W of the secondary winding, but is not shown in the diagram. The terminals of the primary winding are connected with the polyphase leads. Instead of the separate windings W a continuous winding with a so-called artificial neutral point might be used. The action is as follows:—The primary winding produces in known manner a rotary magnetic field, which sets up in the secondary windings alternating voltages in regular sequence of corresponding frequency. At any given time

No 29,763



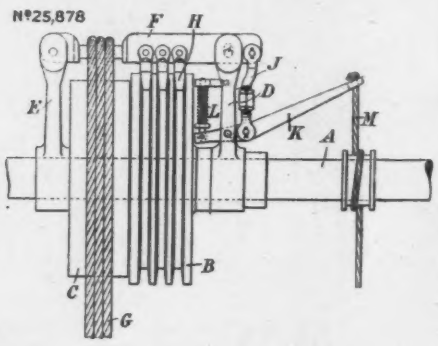

half the electrodes have a positive potential and discharges pass from these electrodes to the mercury of the rectifier. As the field rotates the vapour arcs also rotate. With a certain fall of voltage in the arcs, a pulsating direct current is produced, and the flatness of the waves depends upon the number of the separate windings W. The current over each electrode and the consequent rise of temperature is reduced with the number of parts into which the winding is divided, and the reduction can be carried to any desired extent by increasing the number of such parts.—*May 6th*, 1914.

## MACHINE TOOLS AND SHOP APPLIANCES.

25,878. November 12th, 1913.—DROP HAMMERS, Bernard Brett, Hampton-in-Arden, Warwickshire, and another.

This specification describes improved lifting means for drop hammers. A revolving shaft A carries fixedly a grooved pulley B and loosely a plain pulley C and two arms D E. To the arm E a lever F is pivoted. To this lever the lifting ropes G are attached. The lever carries wedges H engaging the grooves n the pulley B, and is pin-and-slot connected to the arm D.

No 25,878



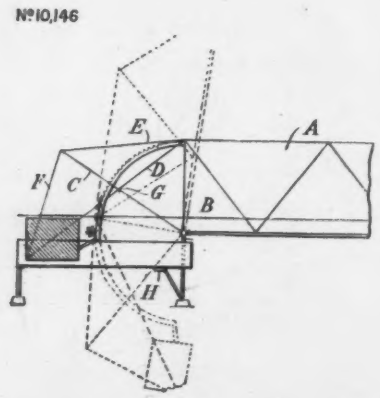

A link J unites the lever F with an operating lever K, one end of which is acted upon by a spring L fixed on the arm D, while the other has attached to it a rope M, which rope is given a turn round a small pulley fixed to the shaft A. A pull on the rope M causes the wedges H to engage with the grooves of the pulley B, so that the arms D E and lever F are carried round with the shaft A and the ropes G wound round the pulley C. —*May 6th*, 1914.

## MISCELLANEOUS.

10,146. April 30th, 1913.—BRIDGES, J. B. Strauss, 104, South Michigan-avenue, Chicago, U.S.A.

This is a new form of bascule bridge. The main span A is pivoted at B and carries a rigid counterweight frame extending rearwardly from it. The counterweight is fixed rigidly to this

No 10,146

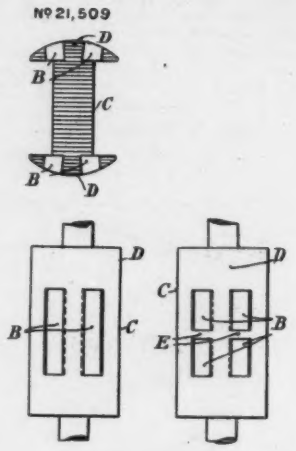



frame. The frame is built up of members C D E F, of which C D are connected at G so as to leave a clear triangular opening below them. This opening permits of the bridge being swung up without the counterweight frame fouling any part of the fixed structure, such as the cross girder H.—*May 6th*, 1914.

21,509. September 24th, 1913.—IMPROVEMENTS IN OR RELATING TO MAGNETO-ELECTRIC IGNITION APPARATUS, William Alexander Hill, 34, Talbot-road, Old Trafford, Manchester.

This invention relates to magneto-electric ignition apparatus for internal combustion engines, and has special reference to apparatus of the kind wherein are obtained or provided two points of maximum voltage, corresponding to the positions of advanced and retarded ignition. According to this invention the cheeks of the armature are provided with longitudinal slots or apertures located near their projecting edges and extending almost throughout the entire length thereof. Only alternate projecting parts of the cheeks of the armature may be provided with slots or apertures, or each projecting part of the cheeks may be so provided. In some cases the slots or apertures may be interrupted at intervals so as to form series of slots or aper-

No 21,509




tures near to the projecting edges aforesaid. The upper left-hand drawing is a cross section, and below it is a plan of an armature C having a longitudinal slot or aperture B provided in each projecting part or side of both cheeks D D. On the right is a similar view showing the longitudinal slots or apertures in the cheeks D D interrupted at E to form two smaller slots or apertures. With the armatures above described as strong a spark is obtained when starting the engine, i.e., with the ignition fully retarded, as is obtained when the engine is running with the ignition fully advanced, and the slots or apertures also prevent eddy currents.—*May 6th*, 1914.

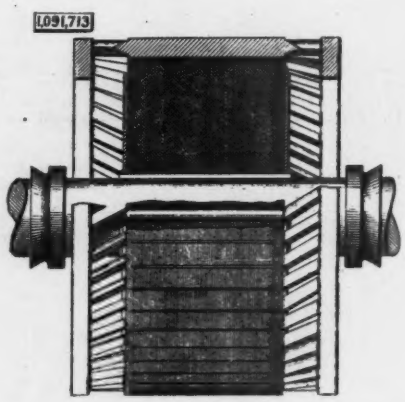
## SELECTED AMERICAN PATENTS.

*(From the United States Patent-office Official Gazette.)*

1,091,713. INDUCTION MOTOR, *C. L. Spinney, Lynn, Mass., assignor to General Electric Company, a Corporation of New York.—Filed September 30th*, 1912.

The rotor has a magnetic core with conductors passing therethrough and projecting outside the core at an angle of less than

1,091,713

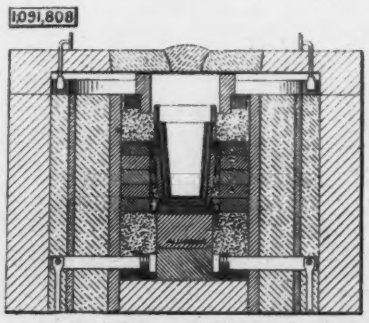


90 deg. with respect to the face of the core. The projecting ends of the conductors are situated substantially within an extension of the cylindrical surface of the core and a short-circuiting ring connects and forms an integral part of the conductors. There are five claims.

1,091,808. ELECTRIC CRUCIBLE FURNACE, *D. F. Calhane, Worcester, Mass.—Filed November 3rd*, 1911.

The crucible furnace has insulating containing walls, and an electrode at the bottom of the furnace and one at the top. Removable and replaceable solid insulating blocks are superimposed one upon the other at the bottom of the furnace for

1,091,808

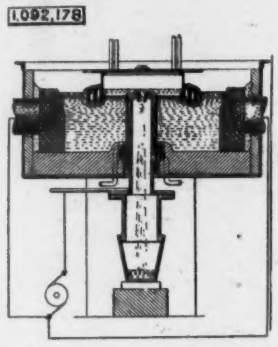


supporting a crucible. A continuous granular packing is arranged around the blocks and crucible, and a series of independently removable insulating rings is arranged one above the other surrounding the crucible, whereby the height of the crucible can be adjusted by removing and replacing the blocks and the zone of the crucible effected by the insulating rings can be regulated by removing and replacing the rings. There are six claims.

1,092,178.—CATHODE FOR ELECTROLYTIC FURNACES, *G. O. Seward, East Orange, N.J., and F. von Kügelgen, Holcombs Rock, Va., assignors to Virginia Laboratory Company, New York, N.Y., a Corporation of New York.—Filed October 10th*, 1910. *Renewed September 10th*, 1913.

The furnace is intended for the separation of metals lighter than their fused salts. It is provided with a central cathode, an outer anode, and an annular insulating partition between

1,092,178

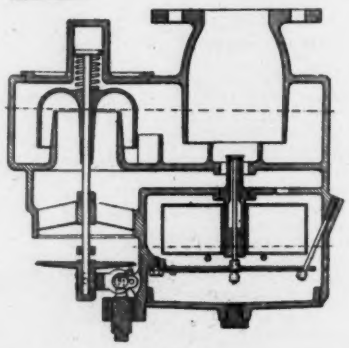


them within which the separated metal is confined and floats on the electrolyte in conducting contact with the cathode. The cathode has a downwardly projecting portion surrounding it and separating it from the electrolyte, and is in conducting contact with it at its upper portion only. There are six claims.

1,092,282.—CARBURETTER, *W. T. Mixsell, Washington, D.C.—Filed April 10th*, 1911.

The oil nozzle of the carburetter is surrounded by the contracted portion of an air passage. A throttle controls the inlet to this passage, and there is a vacuum chamber with an outlet pipe into which this nozzle discharges. The chamber and pipe are unobstructed beyond the nozzle, and a by-pass leads from the

1,092,282

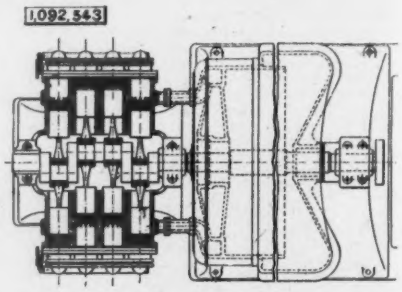


inlet end of the passage and terminates in a secondary annular air outlet surrounding the contracted part of the air passage and spray nozzle and communicates with the vacuum chamber to form a continuous annular enveloping air current in the chamber around the fluid drawn from the nozzle. The object is to prevent precipitation of liquid particles on the surface of the vacuum chamber. There are nine claims.

1,092,543.—ENGINE, *W. Schmidt, Cassel-Wilhelmshöhe, Germany assignor to Schmidt'sche Heissdampf-Gesellschaft M.B.H., Cassel, Germany, a Corporation of Germany.—Filed December 16th*, 1911.

The engine comprises a number of identical single-acting engines arranged in two groups, their cylinders being at right angles to one another. Each group has its cylinders in a plane common to the shaft and disposed in sub-groups of eight with four on one side and four on the other side of the shaft. The

1,092,543

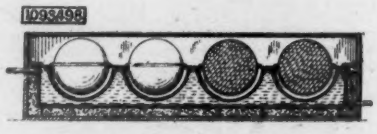


shaft is provided with cranks corresponding to the two engine groups, the cranks all being in a single plane, the cranks corresponding to the four outside engines being opposite to those corresponding to the four central engines. Both cylinders and cranks are symmetrical as to a plane perpendicular to the shaft and midway as to the central engines. There are four claims.

1,093,498.—SUN-POWER WATER HEATER, *A. C. Thring, Philadelphia, Pa.—Filed September 19th*, 1913.

The water heater comprises a casing, a water tank in it, and spaced from its walls. Non-conducting material is arranged in the space between the casing and the tank. The cover of the

1,093,498



tank has openings in it and radiating casings are arranged on the underside of it and under these openings and arranged in the water in the tank. Lenses on the tank cover in the openings and are provided with supporting flanges which bear on the tank cover. There are two claims.

# MAY.

## The Aquitania and the Vaterland.

Two great liners began their maiden voyages during the month. The Vaterland, of the Hamburg-America Line, left Cuxhaven for New York on May 14th, and the Cunard liner Aquitania sailed from Liverpool on May 30th for the same port. The former of these vessels is the largest ship in the world both as regards tonnage and dimension. Her gross tonnage is 58,000, her length 950ft., and her breadth 100ft. The Aquitania has a gross tonnage of 47,000, a length of 901ft., and a breadth of 97ft. Steam is derived in the Vaterland from forty-six single-ended water-tube boilers, and is generated at a pressure of 235 lb. per square inch. The total heating surface is 203,000 square feet, and the total grate area 3760 square feet. In the Aquitania there are twenty-one large double-ended tank boilers, each with eight furnaces. Steam is generated at a pressure of 195 lb. per square inch. The total heating surface is 138,596 square feet, and the total grate area 3542 square feet. Her propelling machinery consists of triple-expansion turbines of the Parsons action type driving four screws. Her total ahead horse-power averages 56,000, giving a normal speed of about 23 knots. The engines of the Vaterland are triple-expansion turbines of combined impulse and Parsons type driving four screws. The ahead horse-power is about 72,000, giving an average speed of 23¼ knots. The full complement of passengers and crew in the Vaterland is 5350, in the Aquitania 4202.

## Wireless Firing of Mines.

The experiments made in Florence during May by Ing. Ulivi in the destruction of mines from a distance by means of electric rays again proved completely successful. Four floating bombs, loaded with various explosives and covered by an inner jacket of tarred string with an outer casing of iron, were set floating in the Arno at the Ponte di Ferro. Admiral Fornari being present with several engineers and a high official from the Admiralty, Ing. Ulivi waited on the Senario hill and, having received the signal, began his work of "searching for" the bombs, which were being swiftly carried down by the current. After a short suspense the first exploded, and the rest met with the same fate at intervals of about fifteen minutes. The last had travelled as far as the Ponte delle Grazie. The rays used by the inventor, and called by him "M rays," traversed therefore a distance of 17 kiloms. and passed across the Fiesole Hills and over the roofs of Florence. It is too early to go into any kind of technical details. Ing. Ulivi has on other occasions communicated from a distance a spark to the interior of a metallic casing though the explosive was enclosed in six boxes made of india-rubber, fibre, china, asbestos—two boxes—and iron. Ebonite and glass have also proved ineffective against him. The destruction of loaded shells or of the powder magazines of battleships is now considered by Padre Alfani, the well-known scientist, as merely the question of a very short space of time, but it is perhaps well to adopt a cautious attitude until further experiments have been made. Trials, it is reported, are, in fact, about to be made on the Nettuno Government range.

## Smoke.

Many years ago, when there was a great deal of agitation about the production of smoke, we opposed the passage of any stringent measures, because in the state of certain industries at the time more harm than good would have been done by legislation, but many changes have taken place in the last fifteen years, and we can now welcome without any grave misgivings an official inquiry into the whole question. We look, therefore, with equanimity on the appointment of a Departmental Committee of the Local Government Board, which was, in the early part of May, appointed "to consider the present state of the law with regard to the pollution of air by smoke and other noxious vapours, and its administration, and to advise what steps are desirable and practicable with a view to diminishing the evils still arising from such pollution." The Committee meets under the chairmanship of the Right Hon. Russell Rea and may be regarded as a fairly representative body. We are particularly glad to note that the interests of machinery owners are to be watched over by the general manager of the Machinery Users' Association, and we note with some satisfaction the omission of the names of several well-known rabid reformers. It must be remembered that there are certain "vested interests" in smoke production, and that ill-thought-out and ill-digested recommendations might do a great deal of serious injury. There is no one that would not rejoice to see smoke done away with altogether; but, on the other hand, we have to consider that in some cases the prohibition of smoke production might cause the destruction of a local industry. We have no doubt that when the Committee gets seriously to work in a few days' time it will be able to collect a mass of information which will throw much light on a vexed problem.

## The English Week in Switzerland.

For some time past all the engineering works in Switzerland have been agitating for what is known as the "English week"—in other words, a Saturday half-holiday. One of the great engineering firms in Baden and Winterthur has already introduced it. The agitation, however, is by no means confined to engineering workpeople, and has now spread to the Swiss Federal Railway servants, who recently petitioned the Swiss Federal Council to allow them to work half-an-hour longer each day from Monday to Friday inclusive, and give them a half-holiday on Saturday. The Federal Council refused this request for reasons of finance and general management; but it is certain that the agitation is not over, and it must be encouraged by the example of the great engineering firm just mentioned, which finds the plan of the Saturday half-holiday work very well indeed. Another instance of continental imitation of the undoubtedly better English hours of work is the introduction by Brown, Boveri of a shortened dinner-time—one hour instead of two—with a proportionately earlier time for leaving off work in the evening. This has also proved a thorough success, and the feeling prevails amongst officials generally that it is time Switzerland changed her hours of work. At present during two hours at noon, between twelve and two, virtually no business is done, everyone's energies being given up to the consumption of a huge midday meal, even the banks being closed.

## Oil Fuel for the Navy.

The Admiralty is taking steps in various directions to ensure an uninterrupted supply of oil fuel for naval purposes. During the month a White Book was published in which certain information was given concerning an arrangement entered into with the Anglo-Persian Oil Company, by which the Government has undertaken to purchase shares and debentures of this company to the extent of £2,200,000, thereby acquiring a predominating interest in the undertaking. It will, moreover, have a right of veto at board meetings. The quantity of oil which it is proposed to obtain from this source has not been divulged, nor has the price, though the terms agreed upon are regarded as being satisfactory. The Government will, saving as above stated, be just a shareholder in the company, reaping, presumably, any benefits which may accrue by way of dividends on its investments. It will, moreover, purchase and pay for what oil it requires just like an ordinary customer. The acquiring of oil from this source has been criticised because, at present at all events, the oil-bearing wells of the company lie many miles inland from the head of the Persian Gulf, which will necessitate the employment of a pipe line running through wild country. It is contended that such a pipe line would be readily attacked and would be very difficult to protect. However, it is safe to assume that this aspect of the matter has been carefully considered. Another quarter of the globe in which the Admiralty is reported to be making special arrangements with a view to acquiring additional supplies of oil is California, but up to the present there has been no official pronouncement on the matter.

## The Fehmarn Route.

The proposed Fehmarn route, which, as already reported in these columns, would considerably shorten the journey between Berlin and Copenhagen, has recently been the subject of much discussion both in Germany and Denmark. In view of the interests involved in the existing lines of Kiel-Korsör and Gjedser-Warnemünde, there is, naturally, much opposition to a competing route, and this was perhaps the principal reason for the temporary rejection of the proposal by the Prussian Diet a fortnight ago. In addition, it was urged that the costs estimated by the Fehmarn Committee, viz., about £1,250,000, were too low and that in reality almost £3,000,000 would be required. In any case, the initiative must be taken by Germany, as an important part of the project is the construction of a bridge or dam connecting the island of Fehmarn with the German mainland. The Prussian decision was followed by a statement of the Danish authorities to the effect that, in their opinion, the Kiel-Korsör route could not be satisfactorily improved by any amount of expenditure. Their proposal therefore was to do their best to accelerate the Gjedser-Warnemünde line and to be in readiness to co-operate in the Fehmarn line when it was finally voted by the Prussian Diet.

## Fuel Alcohol.

On the 20th of the month a little luncheon was given at the Royal Automobile Club by the chairman, Mr. Arthur Stanley, and the members of a committee of that Club which has taken upon itself to bring about legislation which will facilitate the production and sale of fuel alcohol in this country. It is a subject with which we have always been in hearty sympathy, and we wish the committee every success. From the user's point of view there are few, if any, obstacles to the use of alcohol beyond and besides the difficulty of producing it at a price and in a condition suitable for consumption in an internal combustion engine. The difficulties lie almost wholly with the excise officers. In the first place, the perfect denaturant has yet to be found, and in the second, such modifications of present restriction are required as will induce the capitalist to put money into fuel alcohol factories. The committee is fortunate in having secured the services of Sir Charles Bedford, who has acquired a profound knowledge of both subjects by many years' work as Scientific and Technical Adviser on Excise and Customs matters to the Government of India and as Director of the Central Excise Laboratory in that country, but it has also amongst its number men of such profound knowledge as Mr. Tyrer, Sir Boverton Redwood, and Dr. Ormandy. On only one side does it appear to us to be weak, and that is in connection with engine questions; but possibly that part of the problem is rightly considered less difficult, less full of obstacles, than the chemical and legislative part. It is estimated that the work will take five years to carry out, and that it will involve the expenditure of £30,000—a trifling sum compared with the advantages that should accrue. Those who are interested as prospective users of alcohol fuel are to be asked to subscribe to the fund.

## German Shipbuilding Industry.

An interesting sidelight is thrown upon German shipbuilding by the report of the Vulkan Company, which has just been published. It became known some time ago that the Vulkan would not be in a position to pay a dividend for the year 1913, and that it would have, moreover, to draw heavily upon its reserve funds. The actual decrease in the reserves is fixed at £232,000. The report states that the construction of the Imperator is to blame for the deficit, and that the loss involved by the execution of this order exceeded the total gross profits for the whole of the year 1913. It is stated that the possession of the patent for the Föttinger transmitter has continued to prove of value to the company, that it has attracted the attention of all the navies of the world, and that licence contracts have been concluded in almost all large States. The report admits that the recklessness of the offers made by shipbuilders to the German navy has given place to a more reasonable attitude, but that nevertheless the demands made by the navy places burdens on the shipbuilding industry which can only be borne if the builders can count on regular employment for their dockyards while at the same time obtaining satisfactory prices.

## State Working of Railways.

There are few questions upon which the commercial community in France expresses so unanimous an opinion as that affecting the future working of railways by the State. As the right to build and run railways was granted to companies in the form of concessions for a definite period, the time is drawing near when Government will have to decide whether or not it will exercise its privilege to work the railways as a national undertaking. This, indeed, was the primary intention of the State when granting the concessions. The results obtained by the nationalisation of railways in France, Belgium, and other countries have, however, proved so unsatisfactory, and in some cases so disastrous, that the possibility of the French Government taking over the railways is causing serious uneasiness. The matter has been carefully investigated by the Chamber of Commerce of Clermont-Ferrand, which has drawn up a report absolutely opposed to any participation of the State in railway enterprise. The fact that the acquisition of the old Ouest railway system by the State is costing the taxpayers about £3,200,000 per year is held to be a convincing argument against the

nationalisation of railways. The Chamber of Commerce therefore expresses the hope that, on the termination of the present concessions, Government will "farm" out the railways to the existing companies, since experience has proved that such enterprises, "while profitable in the hands of companies, are very often run at a loss when carried on by the State." At present the companies suffer from a serious disability on account of the heavy charges imposed upon them through being obliged to devote increasingly large sums to the repayment of loans. The Chamber, therefore, proposes that the companies should be afforded relief either by renewing concessions or by extending the period for repaying loans beyond the duration of the concessions. This latter solution has been recommended by many authorities on railway finance.

## The International Shipping Conference.

As reported in our issue of April 3rd, the Shipping Conference which met at Berlin in March to arrange the differences existing in international shipping was adjourned after failing to arrive at a result. It met again at Cologne at the beginning of May, and was on that occasion hardly more successful. As in Berlin, the main difficulty was experienced in the discussion regarding the quota to be conceded to the Canadian lines in the new pool. On the other hand, the shipping agreement which had existed up to the beginning of the present year was temporarily renewed until August 5th, when the next conference is to meet in London, and the continental and English lines agreed to raise the steerage rates to £7 and £7 10s. in the transatlantic traffic. Although various questions remain outstanding, such as the participation in the Hungarian lines, &c., the temporary cessation of the tariff war is a matter for congratulation. Another important feature is the more complete agreement arrived at between the Hamburg-America Line and the North German Lloyd, extending as it does to all services except the South American and all but representing an amalgamation of the two companies.

## Railways in the Sahara.

THE official opening of the railway from Biskra to Tuggurt by the French Minister of War marks an important stage in the commercial development of the Sahara, which has been steadily pursued by the French Government for a long while past. It has taken three years to build this line of 135 miles across the desert. There were few engineering difficulties, since the line is laid at an almost invariable altitude of 20 m. above the sea level, but the work had to be undertaken in a burning desert and under conditions which considerably retarded its execution. It is a military line constructed by the army, and, while strategical, its main object is to give commercial value to a vast region which, until recently, produced little or nothing. For this reason Government engineers have been actively engaged in boring for water and have sunk more than 600 wells, which have permitted the creation of extensive plantations of palm trees. At Tuggurt alone there are two million palm trees, and the trade has grown so considerably that it is sufficient to pay for the working of the line. This is merely the beginning of the commercial development of the Sahara. By sinking wells and irrigating the parched territory it is hoped to grow cotton and other produce, and thus gradually to extend the railway system in pursuance of a vast scheme which aims at traversing the Sahara and putting North Africa into railway communication with the Cape.

## The Glasgow Water Bill.

AFTER hearing the promoters' evidence for seven days, the Select Committee of the House of Lords appointed to consider a Bill promoted by the Glasgow Corporation, decided that that part of the Bill in which powers were sought to increase the city's water supply should be rejected. The scheme proposed by the Corporation was to dam up the waters of Loch Voil and Loch Doine, in the Balquhidder district, and to turn the impounded water into Loch Katrine through an aqueduct tunnel. Opposition to the scheme came from nearly all towns, villages, and districts in the Forth Valley, for these regarded themselves as the rightful owners of the waters arising on the eastern slopes of the watershed at the head of the river Forth. Their claims, however, never came to the proof, for the Select Committee dismissed the water portion of the Bill without hearing a single adverse witness, much to the surprise and consternation almost of the promoters. It seems to be implied by the Committee that in its opinion the proper source for Glasgow to tap is either the head waters of the Clyde or Loch Lomond, or alternatively that the city should exercise economy and avoid all necessity for increasing its supply. The Loch Lomond scheme would involve a very expensive pumping plant, to say nothing of new pipe lines, and the water thus obtained would be very liable to be contaminated, for there are several villages on the shores of the Loch and a considerable steamboat traffic on its surface. To tap the head waters of the Clyde would involve an even more expensive programme. The water, too, would have to be brought through a large and densely populated coal and iron mining district, each town of which would probably demand its share, while the aqueduct or pipe line would almost certainly suffer from subsidences. A new scheme has to be found, and found soon, if a serious water shortage is to be avoided in the near future, and in the quandary in which they have been placed the Glasgow water authorities are scarcely to be congratulated. It is understood that they are carefully considering the yield of water which is still available in the Loch Katrine catchment area.

## Effects of Electrolysis.

SINCE electricity began to be distributed upon such an extensive scale in Paris for power purposes on the Metropolitan, the tramways, and on the suburban services of the State and Orleans Railways, the effects of electrolysis upon the gas and water mains have become so serious that the Municipal Council appointed a Commission to examine the question and ascertain whether it would be possible to suggest a remedy. During the inquiry the Commission was shown some extremely interesting examples of the damage done by electrolysis. In some cases lead and cast iron mains were as full of holes as the domestic cullender. In other mains, which in appearance did not seem to have been affected, the molecular character of the metal had undergone such a complete change that it was possible to cut the pipes with a knife. Where the mains had been perforated the molecules were often found deposited in the surrounding soil, which had the appearance of iron or lead ore. Again, the molecules sometimes combined with other minerals and filled up the holes in the pipes. The effects were so varied that the Commission was unable to come to any settled opinion as to the conditions under which the mains were destroyed by the electrical currents. The first report, just published, states that "the problem is very difficult to solve." The electrical distributing companies appear to be doing all they can to prevent loss from the electrical mains, and the regulation of the Minister of Public Works, fixing at one volt per kilometre the loss on electrified lines, does not seem to be practicable, while even when the loss does not exceed this amount the effects in the neighbourhood of the electrified lines are much the same. The Commission now intends to collect further data in order to ascertain the districts in which the effects of electrolysis are most marked, and at the same time to compare these effects with the precautions taken by the different companies to prevent loss of current on their lines. For the moment, the only remedy suggested by the Commission is complete insulation of the water and gas mains.

## Motor Vehicles for War Purposes.

FOR some time the War-office has recognised that in case of war the British Army will in future have to rely almost exclusively upon motor vehicles for transport purposes. This necessity has been brought about very largely owing to the dearth of horses in this country since the advent of the electric tramcar and the motor vehicle; but even if horses were still available in sufficient quantities, it is quite obvious that an army relying on horse-drawn transport vehicles would be easily out-distanced by one equipped with fast-moving motor vehicles. The War Department was therefore well advised when it introduced its scheme for subsidising the purchasers of motor vehicles which complied with certain necessary conditions. The vehicles are divided into two classes, namely:—Class A, intended to carry a useful load of 3 tons; and Class B, to carry a load of 30 cwt. They have to be propelled by petrol engines and the gross weights must not be more than 7 tons 10 cwt. and 5 tons respectively. The control arrangements must be similar, the transmission must be by means of live axles, and the wheels have to be of one specified size. The terms of the subsidy are sufficiently generous to encourage both the users and manufacturers of these vehicles to fall in with the Government scheme. A sum of money, approximately about one-sixth of the cost of the machine, is paid to the owner in quarterly instalments, and this gives to the Government the right to claim the vehicle in case of "national emergency" at prices varying from the original cost of the machines to one-half, according to the length of time that the vehicle has been in use. The trials of vehicles entered for the subsidy, which took place in the Home Counties last month, and which we reported in our issue of the 15th ult., demonstrated that there are not wanting makers who can supply vehicles capable of complying with the Government requirements, and, what is perhaps more important, that these machines lend themselves equally well to commercial work.

## The French Naval Manœuvres.

THE manœuvres of the French fleet during the past month were carried out on a scale that has probably never been paralleled on the other side of the Channel. Nearly the whole strength of the navy was engaged in the various operations. At first, an enemy's fleet coming from the west of the Mediterranean to attack the French or Algerian coast was opposed to two home fleets, one at Bizerta and the other in Corsica. The fleet from Corsica was able to ascertain that the enemy was making for Philippeville, but could not effect its junction with the Bizerta fleet and come in contact with the enemy before Philippeville was bombarded. To this extent the advantage lay with the enemy. In the second phase an enemy's fleet, blockaded by submarines in Bizerta, was endeavouring to effect a junction with a fleet coming from the north. The home fleet drew a cordon between Tunis and Sardinia with a view of attacking the two fleets separately, but was unable to prevent the junction from being effected. The third phase was a pitched battle off the coast of Algeria, and, while of great technical interest, proved to be remarkably spectacular, the submarines and torpedo boats, operating in a calm sea, claiming to do great execution. The feature of the manœuvres was the precision with which the battleships were handled, and on one occasion, when two fleets endeavoured to outflank each other, it was impossible for either to obtain an advantage. The strategical skill displayed throughout the manœuvres was of a high order, and it was evident that the policy adopted of keeping the navy on a warlike footing has given excellent results.

## Aviation Disasters.

THE month has been a calamitous one from the point of view of British aviation. Four members of the Military Wing of the Royal Flying Corps have lost their lives, while one of our most skilful and popular of private aviators has disappeared in a sea fog, and up to the time of writing has been heard of no more. The first disaster occurred at Farnborough on the 12th of the month, and arose from the collision of two Sopwith Army biplanes when at a height of about 300–500ft. above the ground. The two machines had previously been noticed flying unusually close together, and at the moment of disaster one was directly over the other. The upper one was seen suddenly to plunge downward while the lower seemed to shoot upwards. They met with a crash and fell together to the ground. The pilot of the lower machine, Captain Anderson, and the passenger of the upper, Air-Mechanic Carter, lost their lives, while the pilot of the upper machine, Lieutenant Wilson, escaped with severe injuries. On Monday, the 11th of the month, No. 2 squadron of the Royal Flying Corps (Military Wing) left the Montrose Base with its attached mechanical transport on a test flight by stages to Salisbury Plain, there to take part in the Military Wing Concentration Camp. On the 15th the stage set was from West Hartlepool to York. A thick bank of fog was encountered near Northallerton, and one of the machines, that piloted by Lieutenant Empson, with Air-Mechanic Cudmore as passenger, came to grief. It seems probable that the pilot lost his sense of position in the fog, and in attempting to descend mistook his distance above the ground. Both on board lost their lives in the ensuing wreck. Three other machines of the squadron also sustained damage about the same time under much the same circumstances, but fortunately without involving further fatalities.

## Loss of the Empress of Ireland.

AT the moment of writing it is possible to say but little with any certainty as to the appalling accident to the Empress of Ireland in the St. Lawrence. We know that she left Quebec on Thursday night, and that in the early hours of Friday morning she was enveloped in a fog bank, which blotted out a collier, the Storstad, which she had seen, but shortly before, two miles away. We know, too, that soon afterwards the Storstad struck her nearly amidship, and that in little more than a quarter of an hour she had sunk, carrying over a thousand souls to death. Why she was struck we do not yet know, nor why the blow was so rapidly fatal. Both captains, who have fortunately been saved, assert that their ships were going dead slow. Indeed, Captain Kendal, of the Empress of Ireland, had stopped his vessel and had, by his own evidence, signalled the Storstad to

that effect. Captain Anderson, of the latter vessel, asserts that he himself was moving at a very slow pace, whilst he is convinced that the Empress was moving rapidly. In such a conflict of evidence responsibility can be put upon the shoulders of neither captain, and we must await, with what patience we can muster, the reports of the official inquiry, which is to open on the 9th inst. A more serious point for the consideration of engineers and shipbuilders is, why the Empress of Ireland, one of the latest products of naval architecture, should have succumbed so rapidly to a blow from a much smaller vessel. It is said that she was ripped from midships to the stern. If that is proved by the inspection of divers, who can work easily in the depth at which she is sunk, to be true, no further evidence will be required to prove that one or other of the vessels was moving at a high speed at the time.

## Gustav Hamel.

IT is impossible now to accept Mr. Hamel's fate otherwise than as established. Before 5 a.m. on Saturday, the 23rd of the month, he left Villacoublay on a new Morane monoplane fitted with an 80 horse-power Gnome engine. It was his intention to fly to Hendon and subsequently, with his new machine, to take part in the "Aerial Derby" round London, arranged for the afternoon of that day. Stopping first at Le Crotoy, he arrived at Hardelot at 9.30 a.m. From this point he set out at 12·15 to fly across the Channel. The cross-Channel steamer Riviera reported having seen an aeroplane overhead in the afternoon, but if this were Hamel he must have been considerably delayed at the outset of his passage, for Hardelot is on the French coast just south of Boulogne. The weather conditions were certainly against him, and his engine is said to have given him previously some considerable trouble. He disappeared and no trace of him, dead or alive, or of his machine has since then to the time of writing been found. The most likely explanation of his fate is that in the mist which enveloped the Channel on the day he lost his direction and flew either down Channel or into the North Sea, and that when far from help his engine or his petrol supply failed. His position in aviation in this country was brilliant. In the words of an official communication issued by the Admiralty, "he was without question the foremost exponent in these islands of an art whose military consequence is continually increasing," and "his qualities of daring, skill, resource, and modesty merited the respect of those who pursue the profession of arms." He was a British subject, and was the son of a well-known English surgeon. He studied aviation first in France, but spent most of his time and achieved the greater part of his renown in this country.

## Municipal Trading in Vienna.

VIENNA'S municipal indebtedness is piling up rapidly. Since 1898 the city has borrowed nearly thirty millions sterling, and now a new loan is about to be issued for three hundred and seventy-five million crowns, or nearly sixteen millions sterling more. Two-thirds, or even more, of the new loan will be devoted to the development and extension of various municipal ownership undertakings, chiefly traffic systems. The largest single item is six million pounds for building new underground railways to relieve the congested traffic in the centre of the city. The streets in the inner city, lying within the Ringstrasse, are too narrow to admit tramlines, and up to now have had only an indifferent service of horse omnibuses. Just what sort of underground lines are to be built, and where, is not yet decided, but for political reasons the council is going to get the money first and settle later how it is to be expended. Two and a-half millions are to be spent upon new tramways, chiefly in the outlying districts, and there will also be a considerable amount devoted to the extension of the present electric lighting and gas plants. In its electric lighting plant the city has been more fortunate than in other departments of municipal ownership. From the report for 1913, just issued, it appears that the city gained a clear profit in the year of some £400,000 from this plant. The income from all sources was £1,360,000, of which £320,000 was for power supplied to the municipal tramways. This would appear a very satisfactory result were it not that the charges for electric light in Vienna are said to be higher than in almost any capital in Europe. The charge per hundred watt-hours in Vienna is seven-tenths of a penny, as compared with a fraction under a halfpenny in Paris, although it is said that the conditions of production are more favourable in Vienna than in Paris. The power supplied to the tramway service, too, costs just double what it does in Prague, where both undertakings are also owned by the municipality.

## RAILWAYS IN CHINA.

*(By our Special Commissioner.)*

No. IV*.

### NANKING CITY RAILWAY.

THIS small line is the only one of its kind in China. No other city is served by a railway running through it in quite suburban fashion.

Nanking is one of the largest cities in China, and was at one time the southern capital. During the late revolution it was the scene of much fighting between the armies of the North and the South. It was at Nanking Dr. Sun Yet Sen was elected the first President of the new republic, on December 29th, 1911. The Tartar city—the ancient seat of the Ming dynasty—was completely destroyed. I walked through this once city of palaces, and there was scarcely one stone left upon another. Only Munchas lived in the Tartar city, and the common people were not allowed to visit it. In this respect it had some resemblance to the Forbidden City in Peking.

The city line was the conception of the late viceroy, Tuan Fang. The terminus of the Shanghai–Nanking Railway is just outside the city of Nanking, and the Viceroy wished to make it possible for his people to join it from the furthest and most populous districts, for Nanking covers over 15 square miles—enclosed within almost impregnable walls.

The money for the undertaking was furnished from provincial sources, and the line is therefore the property of the Kiansu Government. The cost for the total length of eight miles is given as 500,000 taels, or, say, £8000, a mile. The construction was entrusted to Mr. A. H. Leeme, Mr. A. H. Collinson, who was at that time engineer-in-chief for the Shanghai-Nanking Railway, being consulting engineer. It was finished in 1908. Although there is a junction with the larger line, the city line is run as an entirely separate concern. There are two locomotives, both of American manufacture, and the carriages and wagons were mostly taken over from the old Woosung line, now part of the Shanghai–Nanking. The city line does not pay, income and expenditure being about equally balanced, with no margin for payment of interest.

When the foreign engineers had completed the construction, the working of the line was taken over by Chinese officials, representing the Provincial Government. An annual report is furnished to the Board of Communications, but there is no control exercised from that quarter. The total number of passengers carried annually is about 600,000. There are eleven trains daily each way. The fares work out at first-class, 2d. per mile; second, 1d.; and third, ½d. The total revenue is about £8000 per annum, and this is all swallowed up in working expenses. Besides the fact that no profits are shown, the stock is deteriorating, and the inevitable items of repairs and renewals must be faced soon. A city with nigh half a million inhabitants should be well able to support a service running through it. But this line is too heavy, and the stock is out of keeping with the requirements. It is an extension of the Shanghai–Nanking Railway—one of the heaviest in China—with 4ft. 8½in. gauge, 90 lb. rails, and heavy sleepers, laid across a city which a steam or electric tramway would have served much better. The carriages, too, are the same as those used on the main line, roomy and luxurious enough for a trans-continental journey. The whole thing is an incongruity, and must sooner or later be changed or cease to exist. This line presents an attractive proposition for electrification. Meanwhile, some effort might be made to popularise it by the introduction of lighter carriages carrying only one class of passengers, and the reduction of fares to about 1 cent. per mile. The third-class rate is now 2½ cents, and the average train carries seventy-five passengers, while it lumbers along at the rate of 14 miles an hour with empty first and second-class compartments.

* No. III. appeared May 22nd.

### TIENTSIN–PUKOW RAILWAY.

The railway between Tientsin and Pukow is one of the two main lines connecting the Yangtse Valley with the North, the other and older line being that which has its southern terminus at Hankow. Both of these lines converge on Peking, the Tientsin–Pukow by the Peking–Mukden Railway, the other having its northern terminus at the capital.

The Tientsin–Pukow Railway is part of the great trunk line to the North, connecting Shanghai with the Siberian Railway. The railway from Shanghai to Nanking has been opened since 1908. It took passengers as far as Nanking, and those who wished to proceed North had to take a river steamer from Nanking to Hankow and join the railway there. Now it is simply a matter of crossing the Yangtse from Nanking to Pukow and entering a through carriage there for Tientsin. The journey from Shanghai to Victoria Station, London, can now be accomplished in fourteen days.

The line under consideration was, when a project only, the subject of protracted negotiations. It has always been supposed that the country through which the line would pass naturally fell within the sphere of British influence. In 1898, however, Germany acquired certain rights for railway construction in the province of Shantung, and as the line had to pass through that country, disputes arose, and the British rights were seriously challenged. After much trouble an Anglo-German-Chinese agreement was arrived at, and a joint loan was arranged for the building of the line. The Grand Canal of China was fixed on as the northern boundary of British operations, and from there to Pukow on the Yangtse became the British portion, a length of 236½ miles, out of an estimated total of 628, which turned out to be 631 miles, from Pukow to Tientsin. Under the agreement with the Chinese Government, while the British and German loan syndicates were to provide the necessary funds for the construction of the railway, the work of construction was to be carried out by the Chinese Government, with British and German engineers-in-chief for the respective sections. In the spring of 1908 the chief engineers were engaged, Mr. T. W. T. Tuckey, M. Inst. C.E., who had been for twenty-one years employed on the northern railways, being appointed engineer-in-chief of the southern section, and Herr Dorpmüller, of the Shantung Railway, engineer-in-chief of the northern section. But there was considerable delay in appointing the various Chinese officials, and it was not until the end of July, 1908, that the managing director of the southern section arrived at Nanking, and opened his office there. It is with that section, constructed with British money, that this article deals.

BRIDGE OVER THE HWAI RIVER

### SOUTHERN SECTION.

A preliminary survey had been made for the loan syndicate, but the final survey was not commenced till September, 1908. According to the "China Year-book"—which, by the way, is a publication no writer or worker in connection with China can afford to be without—the line was opened for traffic on June 21st, 1912. This does not mean that the construction was finished, for it is not finished now, a great deal of work being necessary, particularly at the southern terminus. The dates are given to show that, roughly, despite the fact that a revolution took place in the period, and also that the line was

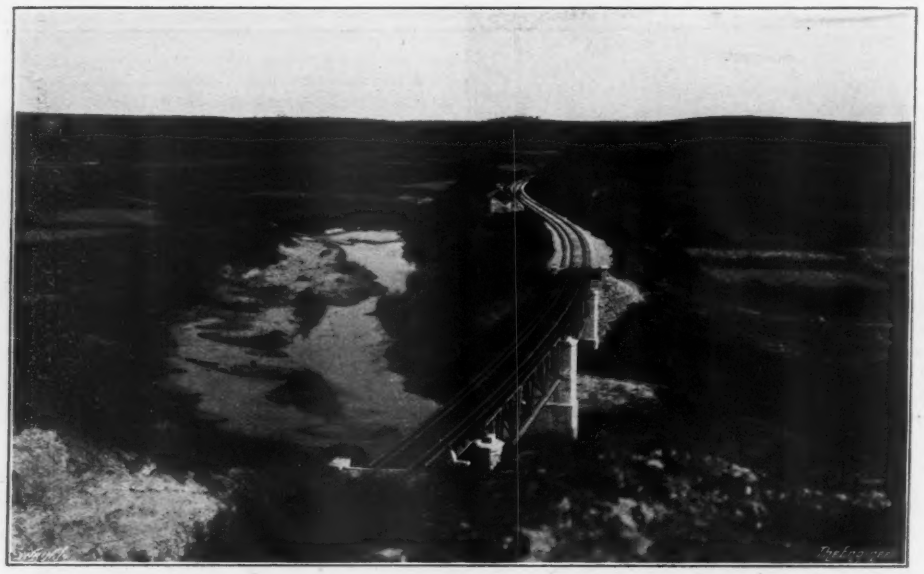
the scene of two battles, the southern section was only four years in building. A ruling gradient of 1 in 100 was fixed by the preliminary survey, but this was improved to 1 in 150 on the final survey. Similarly. it was found that the original curve radius of 1000ft. could be increased to 2000ft. Of course, these advantages cost time and money. but the importance of taking 50 per cent. off the maximum gradient and doubling the curve radius is great, especially on a main trunk line. These changes would be cheap if they represented £1000 a mile on the whole section, but from personal observation I doubt if they cost a tenth of that sum.

The Pukow terminus is situated close to the Yangtze River, with the object of discharging direct into trucks from steamers, and also in view of a train ferry eventually being instituted between the Shanghai–Nanking Railway and the one under consideration. The site is low and was almost continually under water. In fact, it has to be redeemed from the high-water bed of the river. This will be a most important terminus, and it has already cost a great deal of money, although additional sidings, wharfs and cranes, and much more shed room than there is at present, are necessary. And for these, the walls and piers, and even the ground itself, have to be built and raised on what is literally a riverside bog. It has been said by way of criticism that for the present the terminus might have been placed a mile or so from the river on harder and higher ground. The river problem had, of course, to be faced sooner or later, and by doing so at the beginning, Mr. Tuckey had, in addition to the building of a railway, the task of redeeming a great deal of land, and constructing expensive works on it.

For the first hundred miles the line runs through difficult country. There are several long rock cuttings, mostly with hard broken limestone from the hills. The stations are plain, but neat, and contain a good deal of accommodation. All are arranged so that extensions can be made readily when required.

The workshops are situated within the old city of Pukow, the old city wall bounding the site on two sides. Sufficient space has been acquired for a very large works, but for the present only workshops large enough for the erection and ordinary repairs of the rolling stock of the southern section have been built. The main building consists of six 42ft. spans, each 200ft. long, these being used for boiler and smith shop, machine and fitting shop, carriage and wagon repair shop, erecting shop, paint shop and carpenters' shop. Adjoining is a building 200ft. by 42ft., used as a boiler shop, and brass and iron foundry. A store, oil store and offices are the only other buildings at present completed. The shop shafting is driven direct by a single-cylinder Robey fixed engine, steam being supplied by two Lancashire boilers, each 20ft. long by 5ft. 6in. diameter. Eight brake vans and four officers' inspection cars have been built in the works; the water tanks, water cranes, &c., needed along the line have also been made there.

The rolling stock has mainly been purchased from England, except the carriages and wagons, the majority of which have been built in Shanghai, some being obtained from the Continent as well. Two tank locomotives were obtained from America at the commencement. They were wanted in a hurry, and the American makers were able to promise very quick delivery. They have been thoroughly satisfactory. Two tender locomotives purchased later from an American maker, owing to a whim of the managing director, have not proved such good bargains. The passenger locomotives are 4–6–0 type, and have cylinders 20in. by 26in.,



VIEW AT MILE 51

and the maximum gradient had to be resorted to for about 40 miles. There is also a good deal of swamp ground, necessitating high embankments. In one part there is a stretch of flood land of over five miles, where the top of the formation is 20ft. above the ground level.

These flood areas, which are dry three parts of the year, are perhaps the cause of more anxiety in railway building in China than all the other troubles put together. The precarious nature of the subsoil and the difficulty of gauging the extent and rise of the floods must produce many interesting problems and occasion some uneasy hours.

The highest point in the whole section is 224ft. above the level at Pukow terminus. This is reached twice. After the first 100 miles or so, the country is practically flat, although there are several cuttings to avoid long detours and sharp curving. The longest bridge is that across the Hwai River. It has nine spans of 200ft. The piers are founded on steel caissons, sunk by compressed air to solid rock. The Tse Ho bridge has five spans of 200ft. and three of 50ft. The Fei Ho flood opening has sixty-two 30ft. spans. The Huei Ho bridge has one span of 200ft. and twenty of 30ft. All other bridges are under 500ft. in length. Steel girders have been used for all openings above 12ft. span.

The gauge is 4ft. 8½in., the standard gauge of China. The track of both main line and sidings is laid throughout with an 85 lb. rail, British standard flat-footed section, 19,000 tons of rails being obtained from Europe and the balance from the Hanyang Steel Works at Hankow, China. The joints are "staggered," which is a unique feature in China. The sleepers are of wood, 8ft. by 9in. by 6in., and most of them are of Japanese oak, though some Tasmanian timber and some Australian Jarrah has also been used. The line is heavily ballasted throughout, wheels 5ft. 9in. diameter, heating surface 2050 square feet, grate area 28 square feet. The working pressure is 180 lb. The weight on the coupled wheels is 48 tons. The tenders are carried on bogies, and have a capacity of 10 tons of coal and 4500 gallons of water. The goods locomotives are 2–6–0 type, with six-wheeled tenders. The cylinders are 19in. by 24in., heating surface is 1611 square feet, grate area 24 square feet, and the working pressure is 180 lb. The tenders have a capacity of 7½ tons of coal, and 4000 gallons of water. The passenger cars have steel underframes and bodies of teak. They are carried on four-wheeled bogies. The length is 60ft. in every case. The 30-ton cars, low-side, high-side and covered cars, have pressed steel underframes, pressed steel bogies and steel bodies. The 20-ton covered cars have steel-built underframes and steel bodies.

Through traffic to Tientsin was opened in December, 1912, on the completion of the bridge over the Yellow River, on the northern section. The southern section is now practically complete, with the exception of the Pukow terminus, which is a work of considerable magnitude.

Mr. J. Alston is mechanical engineer in charge of the locomotive department, and Mr. Chao Ching Hua is resident director in Nanking.

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IN deciding to build the immense new dry dock, which forms part of Boston's port development, of reinforced concrete with wearing surfaces, or altars, of granite, photographs of reinforced concrete beams formed one of the determining features. These photographs showed that with proper mixing and treatment the combined chemical and frost action of sea water could be neutralised even when the material was subjected to alternate immersion under water and exposure to the air.

## THE GERMAN NAVAL ARCHITECTS.

No. I.

THE summer meeting of the German Naval Architects was opened on May 27th in Stuttgart in the presence of the King of Würtemberg in the hall of the National Museum. After speeches of welcome had been delivered by representatives of the Government and of the town of Stuttgart and by the Rektor of the Technical College, Geheimrat Professor J. Rudloff, of Berlin, read a paper on

"GUNS AND ARMOUR."

Observing that the contest between guns and armour had again become keener, the author said that it really dated from the introduction of the shell in about 1820, but that it had taken a more pronounced form thirty-three years later after the decisive results of the battle of Sinope, when the Turkish and Egyptian flotilla was destroyed in a very few hours by the Russians. Guns of 45 tons weight were built in the early seventies. The Duilio, the Gloire, and the Inflexible, the latter with very thick armour, represented the earlier steps in the development. After the Inflexible armour, had come the Schneider, the "compound," the nickel steel, the Harvey and the Krupp armours, the last-mentioned having a resistance 2½ times as great as that of the old wrought iron plates. Modern armour plates of 350 mm. (13·8in.) in thickness had greater power of resistance than the 610 mm. (24in.) Inflexible armour. Improvements in the design, material and proportions of the gun tubes and the use of better powder had, even for considerably smaller calibres, led to better performances than those of the 45-ton guns. Meanwhile the projectiles had begun to be made of case-hardened wrought steel; their lengths were increased, and they were provided with caps. The 30.5 cm. (12in.) gun was introduced in the middle of the nineties, since which time until quite recently it had held its ground. The power of the 30.5 cm. gun had in Germany been gradually increased, but not in Great Britain. This latter circumstance was attributed by the author to the fact that the British wire-wound construction would not allow of a further increase of pressure; he also stated that, in spite of improvements, the life duration of the wire-wound guns was still unsatisfactory. The increase to 34.3 cm. (13½in.) had been made partly on this account and partly to enable greater bursting charges to be given; it was not intended to give increased penetration, which, for the 230 mm. (9in.) armour plates to be pierced, was already sufficient. The advent of the Dreadnought brought armour up to 279 mm. (11in.), and later up to 350 mm. (13·8in.), though even here the penetration of the improved 30.5 cm. gun was still sufficient at the fighting distances formerly contemplated. Meanwhile, however, the power of the torpedo had been greatly increased, and it was anticipated that the naval battles of the future would be fought at greater distances. Although the more lightly armoured parts of the vessels could still be pierced by the 30.5 cm. guns, it was desirable to have larger guns to pierce the water-line and other thicker armour, and consequently the newer vessels had been designed with guns of 35.6 cm. (14in.) and even 38 cm. (15in.) calibre. As regarded the life of the gun, the author said it was necessary to work with reduced charges in time of peace. He gave some illustrations from British practice, and a formula for the life of the gun taken from THE ENGINEER, 1911, Vol. I., page 399, but avoided giving a comparison between British and German conditions. Tabulated results adduced for some larger and smaller guns showed that a 6in. gun could fire about five times as many shots as a 12in. and about 6½ times as many as a 13½in. gun. Amongst other advantages of the large gun was the increased bursting charge which it made possible in A.P. projectiles, which came nearer and nearer to that of the explosive shell. This suggested the possibility of having one type of projectile on a vessel instead of two. Turning to the Dreadnought and her successors, the author noted with satisfaction that the all-big-gun system was being given up again in favour of that of a combination of larger and smaller guns, which Germany had never abandoned. With regard to the 30.5 cm. gun, it was desirable, in view of the practical advantages of uniformity, to keep it as long as possible, but the advantages of the 38 cm. gun were so great that its adoption was to be looked for. The gun arrangement on shipboard would be simplified by the introduction of this weapon in so far that it would no longer be necessary to put three or four guns in a turret, as had been done in America and in France. The author finally suggested that, since the number of the German war vessels was fixed by law, it was desirable to increase the fighting value of the individual units.

Geheimrat Professor Hüllmann, who rose to discuss the paper, gave expression to the view recently held in English circles that fire superiority was the one factor of importance, as was shown by the naval battles of the past, and said that this was therefore in all cases to be aimed at. Moreover, in addition to the material damage, the moral effects of the blow of a projectile of about a ton in weight and having 400 m. striking velocity must not be left out of account. A further argument for the use of large calibres was the behaviour of the projectiles in striking the water, the larger sizes showing less tendency to

ricochet than the smaller ones. He was sorry that careful firing trials with the 38 cm. gun were not yet available.

In the course of the inspection of the Engineering and Material Testing Laboratory of the Technical College which followed the reading of the paper, Professor von Bach called attention to the importance to the engineer of general education, which in the course of his professional training should not be neglected. Further, scientifically conducted experiment should in future be made the basis of engineering work. For the intellectual working up of the material yielded by experiment, a comprehensive general education, especially in the direction of higher mathematics and technical mechanics, was necessary. Thus equipped, the German engineer would continue to maintain his high position in the world.

Professor R. Baumann, of the Technical College, Stuttgart, then read a paper on

"EXPERIMENTS WITH CASE-HARDENING,"

which, in the main, took the form of a report on the results of experimental work carried on by the aid of subventions from the Robert Bosch Fund. Professor Baumann adverted to the fact that the superficial addition of carbon to parts of machinery subject to wear produced conditions similar to those of the encasing of a soft tough core of metal in a sleeve of harder but brittle metal. The object in view was the combination of these qualities in a finished working part, but it was a matter for investigation in how far the one quality suffered at the expense of the other. If the hard exterior cracked under tension, the inner material had not only to do all the work, but extra local strains were set up in it at the crack. Tensile tests had been made on metals with and without case-hardening and at different temperatures. The tests had been extended to materials heated and quenched at temperatures of 200 deg., 400 deg. and 650 deg. Cent. respectively, and to others that had been slowly annealed. The materials treated were ordinary steel, nickel steel for case-hardening, and chrome nickel steel also for case-hardening. The tensile test samples were 15 mm. in diameter and were case-hardened to a not very uniform average depth of 1 mm. to 1½ mm. Notched bar and other tests were applied. Under the bending test, pieces of sufficient length and not very deep cementation developed numerous cracks. Where the material was not tough, the sample broke directly a crack appeared. In the tensile tests made at ordinary temperatures, the cracking of the cemented outer layer caused the sample to break. Contrary to previous expectation, the same thing happened in tests at high temperatures also. In most of the case-hardened samples, the fractures were at right angles to the axes, but in samples in which quenching had taken place at 40 deg. Cent. they were generally diagonal. One of the latter reached a test load several times as great as those withstood by any of the other samples; to what favourable circumstances this was due was a matter for speculation. Several of the samples, polished and etched, showed the carbon gradually increasing in quantity from the middle towards the edges without any sharp line of demarcation. The special steel samples showed a much finer grain than the iron samples, the transition from the case-hardened layer to the unhardened core being here still more gradual and regular. The Brinell ball pressure test, which in some cases had a tendency to break through the hard crust, gave good results with the special steels also. Under the tensile tests, the un-case-hardened samples that were annealed had an elongation of 31.8 per cent., and when hardened and quenched, they stretched by from 5.4 to 5 per cent. only, this being due to the circumstance that the surface cracked and the resistance of the whole then collapsed. The hardened samples thus showed less tensile strength than the unhardened samples. In the diagrams of stress and elongation shown to the meeting, the lines for the case-hardened samples curved upwards to the point of fracture without the appearance of rapid yield. Diagrams for case-hardened and uncase-hardened materials showed permanent set at points for the former at something like half the loads at which it appeared in the annealed, but otherwise untreated, material. To keep the permanent set point as high as possible, the quenching must be done at a sufficiently high temperature. Case-hardened nickel steel quenched at 400 deg. Cent. broke at 8000 kilos per square centimetre, and up to 4000 kilos. per square centimetre showed little permanent set. When annealed it broke at 4000 kilos. per square centimetre, the permanent set being, up to this point, only slight. Quenched at 200 deg. Cent. it showed considerably more permanent set, and broke at 3500 kilos. per square centimetre. Un-case-hardened nickel steel broke at 3500 kilos. per square centimetre when annealed. When quenched at 200 deg. Cent. it broke at about 8000 kilos. per square centimetre, with little more than half the permanent set of the case-hardened sample quenched at 400 deg. Cent., which broke at about the same load. Comparative tests with case-hardened and uncase-hardened chrome nickel steel showed peculiarities similar to those of the nickel steel. The former broke at loads between 3000 kilos. and 4000 kilos., and the latter at loads between 3000 kilos. and a little above 5000 kilos. per square centimetre.

A series of diagrams giving the units of work required in the notched bar test at various temperatures illustrated the considerable reduction of ductility due to case-hardening. At temperatures of about 500 deg. Cent., the upper limit in the diagrams, a considerable improvement was, in the case of the steel samples, observable. Noteworthy was the brittleness at low temperatures. Case-hardened nickel steel samples quenched at 200 deg. Cent. again showed greater elongation than the mild steel samples. Brittleness at low temperatures was not here manifested; in general, the samples broke after a much greater expenditure of work. Samples quenched at high temperatures—up to 650 deg. Cent.—in several cases behaved remarkably well. The results for chrome nickel case-hardened steel samples were much like those given by nickel steel. The fractures showed the coarsest grain to belong to the mild steel samples. Their appearance seemed to show that the treatment accorded to them had not been the most suitable. Spare samples subsequently heated up to 880 deg. Cent., cooled again in water and quenched at 200 deg. Cent., gave better results. Bending tests gave results which also enabled a judgment to be formed as to the toughness of the material treated. In general, the various tests carried out were thought to show:—(1) The superiority of the special steels for the purpose in view; (2) the importance of the treatment of the material; (3) that the toughness of the core material came into play only to a limited extent. In conclusion, the author recommended that tests be made in particular cases to ascertain whether case-hardening or the choice of a special steel material would be more suitable for parts subject to considerable wear.

A second paper by the same author on

"TENSION AND ALTERATION OF FORM IN RIVETING IN RELATION TO HOLE CRACKS"

was taken as read. After referring to former announcements of the Stuttgart Laboratory on the subject, Professor Baumann wished, in his paper, again to call attention to the importance, first, of the power applied in the forming of the rivet head and of the pressure with which the latter bore on the plates after it was formed; secondly, of the pressure of the hot soft rivet on the sides of the rivet hole; and, thirdly, of the heating experienced by the plates connected. He expressed a warning against the application of excessive pressure by means of hydraulic riveters, and showed that it might even reduce the desirable pressure tending to bring the plates together. The plates were thereby bruised and bent, and the holes were subjected to strong radial pressure, and it was no wonder that cracks showed themselves in cases in which the material was also not of the best. The effects of the application of excessive pressures were illustrated in the paper by a series of sketches. The importance of allowing rivets to cool down and the advantages that might accrue from a cooling of the riveting dies were pointed out. The plate round about the rivets was found to be heated in the process of closing to a temperature of 350 deg. Cent. or more at a distance of 5 mm. (about .2in.) from the edges of the holes. Strains thus set up between the hot and the cold parts of the plate were, it was shown, most intense at the weakest points, *i.e.*, at the edges of the plates opposite the rivets. Strain figures could be observed on the plates when the latter were polished, showing that the yield point had been passed. To enable a distinction to be made between the respective effects of pressure and heat, the Laboratory had pieces of riveting done with cold lead rivets, and then had the latter replaced by hot iron ones put in with the same pressure. In order to produce the flow figures on the plates, much higher pressures had to be applied in the case of the cold than in that of the hot rivets. The formation of the figures began at the points of contact of the plates. With the hot rivets, figures appeared at 15,000 kilos. (nearly 15 tons), or rather more than a quarter of the power available, although the rivet heads were not yet properly developed. The temperatures attained in riveting were often of degrees corresponding with yellow or blue heats, which were usually accompanied by brittleness. As a result of such conditions, cracks might develop later. An examination of a boiler plate in which some of the rivet holes had developed radial cracks showed that the insides of the holes had deep rough fissures probably due to rimering. The material would subsequently have been heated to yellow or blue heats, and the combinations of tension—rimering and heat straining—had sufficed to cause the cracks. Other holes that did not show signs of rimering had escaped without cracks. The punching of rivet holes would on the application of these principles also appear in a new light.

These two papers were not discussed.

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THE jinriksha or man-drawn vel icle so universal in the Far East is being rapidly superseded by a "cycle-riksha," which was first put on the market in Shanghai. It is a basket chair cycle combination, propelled by a coolie riding behind and completely shielded from the passenger. The model is nicely upholstered, has good springs, and is fitted with pneumatic tires. Moreover, according to the *Contract Journal*, there is being manufactured in Birmingham another type of the same vehicle fitted with a motor.

## THE SPLIT-PHASE SYSTEM.

THE experiments that led up to the development of the new split-phase electric railway system that is now beginning to make headway in America were dealt with nearly three years ago in a paper read before the American Institute of Electrical Engineers by Mr. E. F. W. Alexanderson. Since then little has been published about the system; indeed, in this country it has been practically ignored. At the time the paper was read only small apparatus had been constructed, and even in America little importance was attached to the invention, but now that the system is about to be put to the test of practical application it demands attention, and we therefore propose to deal briefly, in the first instance, with Mr. Alexanderson's paper.

It is pointed out that a polyphase induction motor can be made to work with single-phase current by connecting two of its terminals to the supply and giving the rotor a start. A three-phase motor has three terminals, and when the machine is running in this manner it is possible to draw from these terminals three-phase current. The arrangement is shown on the left of Fig. 1, where the machine fed with single-phase current is marked "phase converter," and that operated with the three-phase current derived from this converter "motor." Unfortunately, the output of a phase converter of this kind is unbalanced and the starting torque of the motor poor. It has therefore been necessary to modify this simple arrangement.

The new phase converter can best be considered by dealing with a two-phase machine, as shown diagrammatically on the right of Fig. 1. Phase A of the converter, it will be noticed, is fed directly from the line, whilst phase B of the motor is fed through the windings. Theory and practical results show that the maximum starting torque of such a combination is between 45 per cent. and 50 per cent. of the torque of the same motor when fed with polyphase current. Evidently, then, it would be impracticable to use this arrangement for railway work. The low torque is due to the voltage drop in

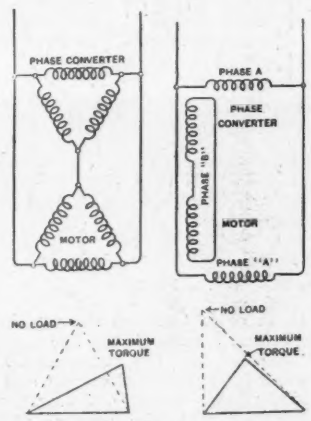



Fig. 1

phase B and the phase displacement between the voltage of phase B and the voltage of phase A. Torque developed by a two-phase motor is proportional to the product of the voltages on phase A and phase B multiplied by the sine of the phase displacement between phase A and phase B. The voltage triangles for an induction converter delivering current to the motor under the conditions of maximum torque are shown under the right and left-hand diagrams in Fig. 1. With a simple-phase converter of this type the voltage at the terminals of the motor is very far from a balanced polyphase voltage, and to improve these conditions it is necessary to correct the phase displacement and increase the current in phase B.

The first remedy that suggested itself was to connect the motor in series with the phase converter, for then the latter is forced to act as a series transformer with respect to phase A and phase B, transforming the current from one winding to the other and displacing it by approximately 90 deg. This was found to improve matters considerably. The torque obtained on the motor with the series connection is about three-quarters of the starting torque obtainable when the motor is fed with polyphase current. This is certainly an improvement, but scarcely acceptable. The reason why the torque is not perfect is that all the lagging current supplied to phase B of the motor must be transformed twice by the phase converter, passing from stator to rotor and back from rotor to stator, thereby causing a considerable drop in voltage. To overcome the difficulty, it was decided to interpolate in phase B a voltage derived from the line, so as to create artificially a phase displacement between the output of the phase converter and the input of the motor. In this way the phase converter is made to give an output of leading current instead of lagging current, whilst the motor receives lagging current as before.

With increase of load the converter tends to raise its voltage, and the voltage and current of the secondary phase can be regulated by selecting a

suitable voltage for interpolation between the windings. Two alternative arrangements are shown in Fig. 2. In the diagram on the left, an auto-transformer is used for supplying the interpolated voltage, whereas in the case of the right-hand diagram, phase B of the converter has more turns than phase A, and the line voltage is used directly for both phases. Tests carried out on this small apparatus are described in Mr. Alexanderson's paper, but as the quantitative data arrived at has no bearing

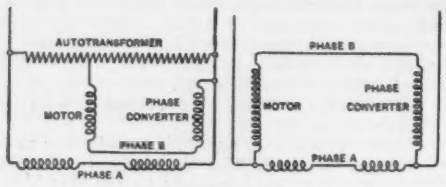



Fig. 2

on the conditions that exist with large machines, they need not be dealt with here.

As stated at the beginning, the paper was read nearly three years ago, and a good deal of new experience has since been gained. A few months ago, our American contemporary, the *Electric Railway Journal*, published further particulars of the system, from which it seems that the phase converter has been altered since Mr. Alexanderson read his paper. The diagram —Fig. 3—shows the connections for the machine in its present form. The line phase of the converter is connected in series with one phase of the motor, and the other phase of the converter in series with the other phase of the motor. By means of an auto-

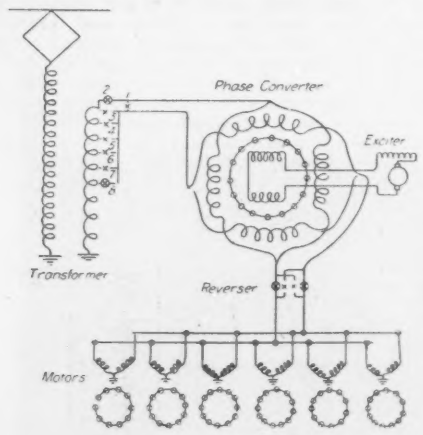



Fig. 3

transformer, or extra turns on the secondary of the main transformer, a part of the line electromotive force is introduced into the last-mentioned phase, thus correcting for phase displacement and reducing the induced electromotive force. So far, the arrangement corresponds with the original arrangement described in Mr. Alexanderson's paper. Now, however, in addition to the squirrel cage winding, an exciting winding is placed on the rotor, and is supplied with synchronous exciting current from a small exciter. This eliminates the exciting current from the main windings, and greatly improves the power factor.

This secondary of the main transformer is provided with tappings to vary the applied voltage, and thus the speed, and for supplying the compensating voltage previously referred to. All the driving motors are connected in parallel, and a reversing switch connects them with the converter. In Fig. 4 the horizontal line O $O^1$ represents the line volts V *l*. This pressure is consumed in overcoming the converter counter electromotive force E *c a*, the motor electromotive force E *m a*, and the impedance drops in the converter and motor. By induction an electromotive force E *c b* is generated in the second phase of the converter, which is in quadrature with

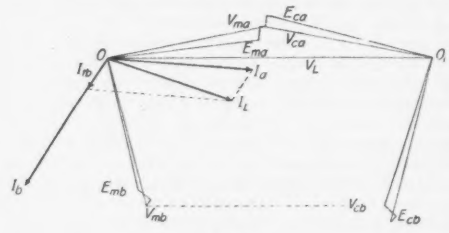



Fig. 4

E *c a* because of the spacing of the windings. A part of the line voltage V *t b*—not indicated—is introduced into phase B—see Fig. 2—and the vector sum of it and the voltage E *c b*—indicated in Fig. 5 by V *m b*—is delivered to phase B of the motor. By the addition of the voltage V *t b*, which is, of course, in phase with V *l*, V *m b* is brought practically in quadrature and equality with V *m a*.

Lastly, a part of the voltage V *m b* is used to overcome the motor impedance, leaving as the motor counter pressure the electromotive force E *m b*. By connecting the phases A—see Fig. 2—of the motor and converter in series, the former becomes a series transformer, the secondary of which gives a current practically equal to and in quadrature with the primary current. This series transformer differs from the ordinary type only in this quadrature relation of the currents; which is due to the production of the secondary current by the motion of the secondary conductors through the primary flux. This flux, it is to be remembered, is approximately in quadrature with the primary current, and the secondary current is approximately in phase with the flux. A current I *a*—Fig. 5—is drawn through phase A, its value and phase depending upon the load and impedance of the circuit. There is also drawn through the auto-transformer a current I *t b*, due to the connection of a part of its turns with phase B. Its relation to I *b*—the current in phase B—is determined by the proportion of turns included in phase B. The line current is the vector sum of I *a* and I *t b*. As the current in phase B is the secondary current in a series transformer, it is proportional to the primary current, and with the same number of turns in each winding the two should be equal. They should, moreover, as already pointed out, be in quadrature, and would be so but for the

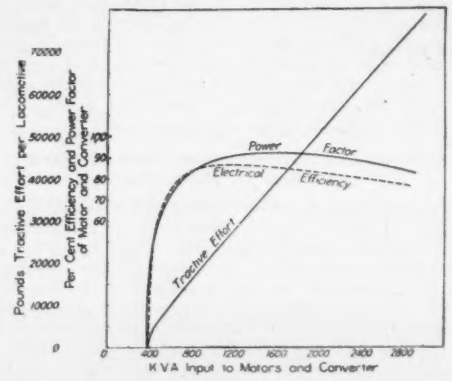



Fig. 5

presence of impedance and magnetising current. But the effect of impedance can be eliminated by the auto-transformer voltage, whilst the synchronous excitation eliminates the wattless current. It is known that in an ordinary transformer the primary and secondary currents cannot be exactly equal and opposite, for this would mean that there would be no magnetisation of the core. The phase displacement adjusts itself to produce a resultant current to set up the required flux. The same applies to a two-phase converter. With equal currents in quadrature there would be no magnetising current; therefore the phase displacement adjusts itself automatically to some value less than 90 deg., and so produces the requisite magnetising component.

If a transformer were provided with an extra winding, and if this winding carried quadrature magnetising current, the phase displacement between the primary and secondary currents would be exactly 180 deg. Or if the extra current were increased above the necessary value, the phase displacement would be more than 180 deg. The flux could not be increased, for this would mean that the counter electromotive force would then be greater than the applied electromotive force. The primary and secondary currents must then produce a demagnetising component to keep the flux at its proper value. It is so with the phase converter. The extra winding on the secondary or rotor produces any desired phase displacement between I *a* and I *b*, which are exactly in quadrature with one another with complete neutralisation of the magnetising component. In Fig. 4, I *a* and I *b* are more than 90 deg. apart, which shows that the converter is over-excited. Examination of Fig. 5 reveals the fact that the machine is capable at all loads of maintaining a high power factor.

Two years ago the American General Electric Company constructed an experimental locomotive and equipped it with a 200 horse-power motor arranged to work as a phase converter. It has a squirrel-cage winding, and was tested with and without an exciting winding. To one axle of the locomotive was fitted a 250 horse-power motor, having a temporary steel cylindrical rotor with no winding. With this crude locomotive some very satisfactory tests were made under very severe conditions, and it was found possible to accelerate the engine whilst the current was frequently interrupted, for as the phase converter runs light it looses little speed when the current is switched off, even for half a minute or so. The momentum of the rotor is considerable, for there is no resistance except friction and windage, the excitation failing with the power supply. It was also found possible to apply full voltage whilst the locomotive was stationary and the controller in the "full on" position. The converter picked up rapidly, and the motor developed sufficient torque to slip the wheels. Finally, the current collector was lowered for a period of one minute whilst the locomotive was running at full speed. The controller was then set for the reverse direction of running, and the current collector raised again. Promptly, the motor developed full torque in the reverse direction, and the wheels slipped as before. These tests led the company to build a 1600 horse-power converter, having six 300 horse-power motors, and intended to produce at 15 miles per hour a tractive effort of 45,000 lb. and 30,000 lb. at 22 miles per hour. The company is also developing some interesting speed control systems, one of which is a new pole-changing scheme.

## THE SUB-DIVISION OF SHIPS.

AT the time when the text of the Convention for the Safety of Life at Sea was published three months ago it was very obvious that the importance of many of the clauses embodied therein was insufficiently appreciated for the moment, and though there is no danger in the future of these points being overlooked, particularly now that the Empress of Ireland has been sunk by a collision which has some elements of resemblance to that which caused the loss of the Titanic, some of them call for more than ordinary attention, though none to the extent that the new requirements relating to construction demand. That a much more standardised principle of settling the general features of the sub-division of new vessels was necessary in place of the somewhat vague regulations that were in force between 1891 and the beginning of the present year—and which, incidentally, were invariably considerably exceeded in practice—cannot be gainsaid; but the question was one of considerable complexity, and in view of the safety of passenger travel and the broad fact that, until the time of the Titanic disaster, such bulkheads as had been provided had generally sufficed to restrict the flooding of a vessel to the compartment most immediately concerned, coupled with the general insistence on the part of owners of all first-class vessels that statutory requirements should be greatly exceeded, it is hard to find fault with the system, which, in itself, was one that was carefully guarded by minute examination of the individual merits of all cases arising in which the statutory sub-division was left in rather a nebulous condition. The fact that this is now to be so drastically legislated for under the clauses of the Convention does not relieve the Bulkhead Committee of the ônus of preparing an exceptionally detailed final report in view of the extensive provisions of the International Agreement, which were mainly based on an interim report prepared for the purpose; but the work involved has been considerable and the importance of the subject demands more than ordinary care in view of the far-reaching nature of the recommendations that will require to be made.

The attention that was devoted to the question of the sub-division of ships at the recent meetings of the Institution of Naval Architects was almost entirely confined to special lines of work, and, even so, was only alluded to as a matter of detail. Mr. T. G. Owens, of Vickers Limited, touched on the question as affecting the design of battleships, and Mr. L. Peskett, of the Cunard Company, dealt with the aspects of sub-division as influencing both the strength and operation of merchant vessels, and those in the North Atlantic trade more particularly. Both authors introduced some debatable and highly controversial points. Naturally, the claims that can be advanced for and against sub-division differ considerably in the two cases, but by no means as far as might be imagined, while at the same time the principles involved are almost identical. Every designer of a ship, whether of a North Atlantic mail steamer or of a super-Dreadnought for a minor Power, does not sub-divide a ship more than he thinks is necessary for safety, nor, as a rule, does he neglect sub-division when by increasing it he can simultaneously utilise it for adding to the structural strength of the ship or to convenience of operation. The requirements of both designers are not so different in this respect as might be imagined.

Any warship, practically without exception, is built mainly on the longitudinal system—that is to say, the longitudinal portions of the structure are made continuous and the transverse portions are worked in in short pieces in between. Merchant steamers, on the other hand, are generally constructed with great transverse strength in view of the margin of strength required for carrying cargo. Nevertheless, in spite of this general fundamental difference, many of the problems of sub-division are common to both types of vessel. These, however, were not those with which the framers of the regulations embodied in the section on construction of the Convention for the Safety of Life at Sea were mostly concerned. Theirs was a task of no little difficulty, in that they had to lay down for future guidance international rules capable of general applicability for the safety of merchant steamers from the point of view of sub-division only, and these rules are intended to cover all classes of vessel. The designer of a battleship, especially if it be one of those occasional units that a foreign Power orders, is not trammelled by general limitations at all, and can arrange his sub-division to suit the merits of the case and the possibly more exigent requirements of the local inspecting Naval Commission. The consulting naval architect of a

large shipping company has hitherto had his hands tied, to an extent limited only to the provision of sufficient bulkheads to satisfy a fairly lenient survey, and even now suffers from comparatively small additional requirements beyond those that he habitually did his best to supply. But those responsible for the new regulations were faced with the problem of regulating the sub-division of all future vessels from 200ft. to 1000ft. long or more in a logical and scientific manner in place of the haphazard methods that had held good since 1891. In spite of the difficulty of framing regulations that must bear a very considerable influence on future hull designs—and as they remain at present, prior to the long expected report of the Bulkhead Committee, must be somewhat incomplete, the clauses to which all vessels laid down after July 1st, 1915, must conform bear evidence of very careful thought and consideration. That they will inevitably cause an increase in weight and cost of hulls cannot be avoided; it is the price that must be paid for increased security.

The broad basis on which the whole question of sub-division was considered, and which includes those of bulkheads, double bottoms, water-tight doors, &c., was that ships should be "as efficiently subdivided as is possible, having regard to the nature of the service for which they are intended," but the Convention went no further than to lay down—and the rules are sufficiently sweeping to affect designers, estimators, and the building staff considerably—the *minimum* requirements necessary for a given degree of safety, which varies with the length of ship and with a certain "criterion of service." The regulations are so framed as to provide the highest degree of safety in ships of great length primarily engaged in the carriage of passengers. In other words, the vessels on the North Atlantic will probably be made structurally the safest of all, a record that if statistics are to be trusted they have already apparently held, in spite of the admitted custom of steaming full speed ahead at night in the presence of ice.

The regulations regarding sub-division are entirely independent of other sections of the Conference report and have no connection with safety of navigation or life-saving appliances, each of which is to form its own ideal. But whereas regulations on these points can be made extremely clear and definite, the standard of sub-division offers vastly more intricate problems, and it is here where the regulations seem to be distinctly incomplete. Whether they are purposely so in order not to clash with the forthcoming Bulkhead Committee report we cannot say; but they certainly require further explanation. For although the load-water line is the water line used in determining the sub-division of the ship, the spacing of the bulkheads to be fitted is arrived at by multiplying the calculated "floodable length" by a "factor of sub-division" which varies according to the class of ship and service. That the members acting in this section of the International Conference were greatly guided by an interim report prepared by the Bulkheads Committee of the Board of Trade for their assistance is well known, and, consequently, it may be deduced that the final report will follow closely on the same lines. It is to be expected, therefore, that the Conference regulations on the subject of sub-division will be explained at much greater length.

This "floodable length," on which so much is destined to hang in future, is to be determined by taking into account form, draught, and other limiting characteristics, but it is best explained as the maximum percentage of the length of the ship—having its centre at the point in question—which can be flooded under certain circumstances without the ship being submerged beyond a line drawn 3in. below and parallel to the uppermost continuous deck to which all the transverse bulkheads are carried. In some ships a continuous bulkhead deck will not appear, and in their cases a measure of safety at least equal in effectiveness to the preceding case must be provided for all conditions of trim after damage. In the calculations of floodable length it has been found essential to make certain assumptions with regard to the exclusion of water from the flooded spaces on account of machinery, cargo, coal in bunkers, &c., and to enable these to be brought to a common basis a percentage permeability has been assumed for the machinery space, the portion forward of the machinery space, and the portion aft of the machinery space. We do not imagine that the Conference regulation with regard to detail cases is yet any too clear as regards the determination of floodable length, though the principle seems perfectly sound.

It is, however, fundamentally necessary to arrive at this length before any final adjustment of bulkhead positions can be reached. In practice, we fancy, it will really only lead to carrying the transverse bulkheads up about a deck higher in most cases, and possibly the addition of another transverse bulkhead in the portion forward of the machinery space. But at first sight it seems probable that the amount of additional work involved in a ship designing office in calculating the effect of flooding various sections lest the ship be submerged below the margin line at those points will be considerable.

The permissible length of one compartment is obtained from the floodable length by multiplying that length by a factor of sub-division which depends primarily on the length of the ship and on a "criterion of service" which, as the Convention admits, is to form the subject of further study. Generally speaking, this latter variable will be used to differentiate between vessels of the passenger type and those of the cargo-carrying and mixed types. The regulations contain a table of factors of sub-divisions which form maximum and minimum points on two curves, and from these it is seen that while for vessels of over 685ft. in length there is virtually little difference in the factor, the figures for vessels from 260ft. to 500ft. vary considerably for the two types of ship. The permissible factors vary from 0.34 in ships 900ft. long to 1.0 in vessels of 260ft.; but even after the calculation of floodable length has been made and the factor applied considerable further adjustment to the number and position of bulkheads between the machinery space and the bow will require to be made, based on the water-line length of the vessel. In fixing this forward sub-division so carefully the Committee have obviously recognised the greater likelihood of danger occurring to the forward rather than to the after portion of a vessel. The maximum length of any one compartment is not to exceed 92ft., and in this connection it is interesting to recall that the stokeholds in the Mauretania and Aquitania, which each contain two rows of double-ended boilers with a common firing space between them, and which are probably the largest stokeholds afloat, are about 81ft. and 78ft. long respectively.

The necessity of basing sub-division on an arbitrary criterion, such as the floodable length really is, will be fully appreciated by those who are responsible for the internal arrangement of large intermediate vessels carrying both passengers and cargo, and in which it is essential to reduce the fore-and-aft length of machinery space as much as possible. In faster and consequently higher-powered vessels other considerations arise, and it is found possible to adopt fore-and-aft bulkheads in many cases in addition to the transverse sub-division. The most striking instances of this, of course, are found in the large vessels of the Cunard Line. In their case, this method of sub-division possesses, apart from its greatly additional degree of safety, the merit of having the bunkers at the sides of the vessel in such a manner that a long coaling front is secured where in purely transversely divided vessels, such as the Olympic, the difficulty of trimming is added to the greater length of time required to coal. Without considerably extending the length of the stokeholds, it is almost impossible to adopt this system of longitudinal bulkheads on large intermediate vessels, and hence, in their case, the number and height of transverse bulkheads will have to be increased.

We may reasonably expect to learn something about horizontal sub-division in the Committee's report in amplification of the much-discussed water-tightness of the bulkhead deck; but it would appear difficult to add much to the drastic regulations as to openings in water-tight bulkheads to which builders and owners will have to conform in future, and the clauses relating to them read more like those of an Admiralty battleship specification than those which are generally found in mercantile cases. Nevertheless, it is quite impossible to point to any of these clauses and allege that the matter dealt with is redundant. The principle aimed at and attained throughout has been one of achieving a degree of safety by means of international regulations that leave nothing to chance, even though they may increase the cost of construction. For instance, in future every vessel between 200ft. and 249ft. long will be fitted with a double bottom between the machinery space and the fore peak bulkhead, and in ships between 249ft. and 300ft. long this double bottom will also extend aft from the machinery space to the after peak bulkhead. In ships over 300ft. long, and this regulation catches nearly all the new Channel steamers, the double bottom shall extend fore and aft and the inner bottom be carried out to the ship's side so as to protect the bilges. In vessels 700ft. long this double bottom must be carried some way up the ship's side. This new regulation is perhaps one of the most drastic that has been embodied in the Convention.

What we may further look forward to in the Bulkhead Committee's report is a lengthy statement on the scantlings of water-tight bulkheads. There is no doubt that the areas of some of these bulkheads are such that had they been tested with water in bulk instead of merely having to withstand a hose test for tightness, that the stiffening employed would be found lamentably insufficient. On this point the regulations do not help us, but it is also one that is bound to receive attention and almost certain to result in further increases of strength. When the strength of the battleship bulkheads is considered the disproportion between their stiffness and mercantile practice is very marked.

In conclusion, we must again emphasise the fact that the apparent incompleteness of the Conference rules on construction is mainly due to the magnitude and complexity of the subject of sub-division. What, however, has been clearly laid down—and there seems no probability of its being evaded in any way—is the definite principle of basing the spacing of transverse bulkheads on the floodable length—in other words, of substituting a scientific and logical method of sub-division for the "rule of thumb" systems that, in spite of any original basis of calculation, have long since outgrown their range of applicability. That they are the outcome of careful research and discussion is obvious, but their value will be greatly enhanced by the publication of the final report of the Bulkheads Committee, and it is to be hoped that this document will be forthcoming at an early date.

## THE FRENCH DESTROYERS BISSON AND RENAUDIN.

AMONG the torpedo-boat destroyers recently taken over by the French Admiralty are the Bisson and the Renaudin, which were both built in Toulon Dockyard, both boilered by the navy works at Indret, near Nantes, and both engined by the Maison Breguet, of Paris. Before being taken over both vessels completed satisfactory trials, though during some of them anything but good weather was experienced.

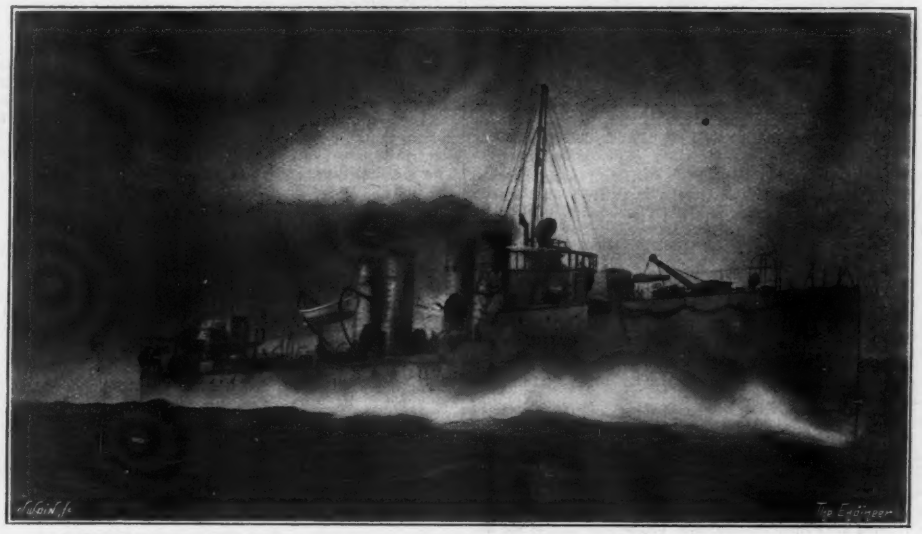


Fig. 1—THE FRENCH TORPEDO BOAT DESTROYER RENAUDIN

The leading particulars of the Bisson and Renaudin are as follows:—

| | |
|---|---|
| Length between perpendiculars | 256ft. 2in. |
| Beam | 25ft. 8in. |
| Depth | 10ft. 9in. |
| Draught, aft | 9ft. 9in. |
| Displacement | 715 tons |

The hull in each case is of Siemens-Martin steel, having a breaking strength of 38 tons per square inch with an elongation of 15 per cent. The stern posts, shaft brackets, and rudders are all of cast steel. The stem is of forged steel, and there are lugs for the attachment of the forward stringers. With the exception of the stem, the hull is clincher riveted throughout. The keel is of teak, 10in. by 5in. in cross-section. There are five kelsons and two bilge keels. The hull is divided into ten water-tight compartments by transverse bulkheads, of which the first three forward comprise a collision compartment, the crew's quarters, and a store, provision room, black powder and ammunition rooms, and a chain locker. Compartments 4 and 5 contain the boilers and 6 and 7 the engines. Compartments 8 and 9 contain the officers' accommodation and the petty officers' quarters, while the tenth is a collision compartment.

Special attention has been paid to the quarters of the officers, petty officers, and crew. All these are heated by coal stoves and lit by electricity. Fans with a total capacity of 70,000 cubic feet of fresh air per hour are installed for ventilation. The forward freeboard is high, as will be realised from the illustration which we give of the Renaudin in a seaway. The navigating bridge is 18ft. above

load water-line, and so is the chart-room, in which are arranged the telegraphs, voice pipes, boiler, air pressure and turbine gauges, steering gear, &c., so that the bridge is in communication with all parts of the vessel. The two-cylinder steering engine is just below the chart-room. It works on to the tiller by means of wire ropes which run along both sides of the deck. The maximum rudder angle is 35 deg. on both sides.

These destroyers each carry a 23ft. lifeboat, a 23ft. whale boat, and two 12ft. canvas boats. There are seven anchors, two of which are bow anchors weighing 1700 lb. each, and three kedge anchors weighing 600 lb. each.

Steam is supplied to the main engines and auxiliaries by two du Temple water-tube boilers arranged for burning oil fuel. There is a total heating surface of 20,494 square feet. The maximum steam pressure is 228 lb. per square inch, and the maximum air pressure in the stokeholds 180 mm. Air is supplied by four fans, which are designed to deliver 2,118,000 cubic feet per hour. The total fuel capacity is 160 tons. There are two Thirion pumps, each having a capacity of 30 tons per hour. The electric power is generated by two dynamos, each having a capacity of 12 kilowatts and each driven by a paraffin engine. A searchlight, 24in. in diameter, is mounted above the chart-room. The wireless station is arranged aft in the officers' quarters.

The main engines consist of two Breguet marine turbines with compound blades, each driving a propeller 7ft. in diameter and 6ft. 5in. in pitch. The turbines have been designed to run at 630 revolutions per minute and to develop 14,500 shaft horse-power with a steam pressure of 171 lb. in the steam chest. The contract speed of the boats is 30¼ knots. We have so recently described the Breguet marine turbine—see our issue of August 15th last, in which the turbines of the Commandant Rivière were illustrated—that it will not again be necessary to describe them. A comparison between the drawings then given with those in our two-page coloured Supplement of to-day will show what modifications in the design have been made. Each turbine in the Bisson and Renaudin is arranged in

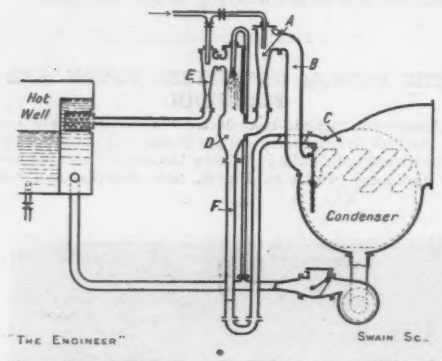



Fig. 2—THE EJECTAIR AND SURFACE CONDENSER.

a separate water-tight compartment with all its auxiliaries, and each turbine casing contains an ahead and astern set mounted on the same shaft. The cooling surface of the condensers is 10,764 square feet.

On the official trials the following figures were recorded :

*Six Hours' Full-speed Trial.*

| | Bisson. | Renaudin. |
|---|---|---|
| Displacement | 717 tons | 721 tons |
| Draught, amidships | 8ft. 5in. | 8ft. 6in. |
| Draught, aft | 9ft. 8in. | 9ft. 6in. |
| Boilers under steam | Four | Four |
| Steam pressure at boilers | 221 lb. | 226 lb. |
| Steam pressure in steam chest | 170 lb. | 179 lb. |
| Air pressure | 151 mm. | 160 mm. |
| Fuel pressure at burners | 100 lb. | 80 lb. |
| Revolutions per minute | 612 | 599 |
| Speed—average of six hours' running—knots | 31.05 | 30.55 |
| Shaft horse-power | 15,000 | 15,100 |
| Vacuum at condensers | 675 mm. | 668 mm. |
| Fuel consumption as per contract at 30·5 knots | 12.155 tons | 12.155 tons |
| Fuel consumption actual at 31.05 and 30.55 knots respectively | 10.250 tons | 10.250 tons |
| State of the sea | Rough | Rough |
| Best run on measured mile | 31.98 kts. | 31.267 kts. |

*Eight Hours' Consumption Trial.*

| | Bisson. | Renaudin. |
|---|---|---|
| Displacement | 712 tons | 711 tons |
| Boilers under steam | Two | Two |
| Steam pressure at boilers | 213 lb. | 216 lb. |
| Steam pressure in steam chest | 178 lb. | 186 lb. |
| Air pressure | 40 mm. | 33 mm. |
| Fuel pressure at burners | 100 lb. | 72 lb. |
| Revolutions per minute | 239.7 | 241.5 |
| Average speed | 14.03 kts. | 14.27 kts. |
| Shaft horse-power | 780 | 910 |
| Vacuum | 742 mm. | 737 mm. |
| Fuel consumption during trial | 2370 lb. | 2487 lb. |
| State of the sea | Slight swell | Calm |

A new invention of the makers of the turbines, namely, the "Ejectair Breguet," was used for the first time on board the Renaudin. It is a dry air pump, which has no moving parts, and of which the simplicity, safety, and stability made, we are informed, a considerable impression on all the technical men who saw it at work. This apparatus is, we gather, of small weight and size, and does not require more than 275 lb of steam per hour when the turbines are working at full power.

The "éjectair Breguet" is shown diagrammatically as applied to a surface condenser in Fig. 2, and to a Breguet jet condenser in Fig. 3, and an examination of these will make the working of the device quite clear. In both cases a centrifugal pump is employed to remove the condensed water, and in both cases the same letters are used to denote the same parts. The vapour and air are withdrawn from the condenser C through the pipe B by means of a steam ejector A, the delivery from which is into a subsidiary condenser D, the cooling of which is brought about by means of a Breguet spraying nozzle. The discharge from this nozzle, together with any vapour which it may have condensed, are delivered into the U tube F, the other end of which is connected to the body of the main condenser. This water, therefore, is added to the condensed water and is not wasted. In communication with the subsidiary condenser is an auxiliary ejector E, which withdraws any air or vapour still remaining in the subsidiary condenser. The exhaust from the latter ejector is into the hotwell. The pipe F is given its particular form for three reasons, which are as follows :—(1) To allow of a difference of pressure to exist between the two condensers C and D ; (2) to allow of the water discharged from the nozzle in D, together with any vapour it may condense, to escape ; and (3) to prevent any passage of air between the two condensers.

The Breguet firm not only claims that a very high vacuum is produced, but also that a very high efficiency is attained. A vacuum of 99.5 per cent. of that theoretically possible is, we understand, guaranteed, and the expenditure of steam in bringing this about is comparatively small.

The armament of these destroyers consists of four 18in. torpedo tubes arranged in pairs above the turbine-rooms.

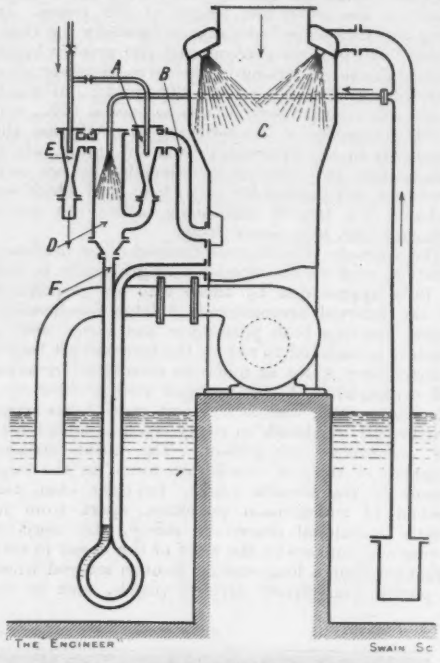



Fig. 3—THE EJECTAIR AND JET CONDENSER.

Each vessel carries six torpedoes. There are also two 4in. quick-firing guns, one forward and the other aft, and four 2.5in. guns at the sides. One hundred rounds for each of the 4in. guns and 375 rounds for each of the 2.5in. guns are carried. The shells are conveyed by electric hoists from the ammunition rooms to the guns. The ammunition rooms are ventilated by electric fans.

## HARD WOODS FOR THE CONSTRUCTION OF RAILWAY ROLLING STOCK.

SOME months ago Dr. Weiskopf, director of the Hannoversche Waggonfabrik, of Hannover, contributed a long paper on the subject of hard woods to the Verein Deutsche Maschinen-Ingenieure. The following is a brief *résumé* of it :—

Japanese oak being used in the Hannoversche Wagenfabrik, the question arose whether this material which has been imported in large quantities and has been used by many other railway rolling stock builders, fulfilled the conditions laid down by the Prussian State Railways. In its appearance, susceptibility to treatment and other properties, Japanese oak does not differ from German, Russian and Slavonian oaks hitherto used without any objections. Proofs, however, had to be brought forward that there were no objections to the use of oak of Japanese origin. For this purpose four kinds of oak were selected from the company's stock, viz.:—(1) Fine German oak, with narrow annular rings ; (2) coarse German oak, with wide annular rings ; (3) Japanese oak ; (4) Slavonian oak. Each kind was subjected to the following three tests :—(*a*) Compression, (*b*) tensile, and (*c*) bending.

### (*a*) COMPRESSION TESTS.

Cubes of oak well seasoned and ready for constructional use, measuring 10 cm. by 10 cm. by 10 cm. were tested on Schenk's testing machine, and very interesting results were obtained. Curves were plotted with the abscissæ representing the loads in kilogrammes, and the ordinates the number of millimetres of compression of the tested piece.

Curve I., Fig. 1, shows the results obtained with fine German oak, the pressure being applied parallel to the fibres. It will be perceived that shortly before 30,000 kilos. is reached the curve descends sharply, forming the small arc *a*, and immediately afterwards drops vertically, the crushing limit being attained at 29,850 kilos. The following portion of the curve is really not very important, because deformation of the block has taken place. On continuing the observations, however, it has been found that the curve retreats towards the ordinate, but still moving away from the abscissæ to such an extent that for a load of 25,000 kilos. its distance therefrom is 17½ mm.; that is to say, the block opposes so little resistance to the crushing action that it has been compressed by 17½ mm. On examining the block it was found that the fibres were partly crushed together, partly laterally displaced. Curve II., Fig. 1, is very similar to Curve I. This block withstood a load of 27,890 kilos., and after the test had a similar appearance to the preceding test piece.

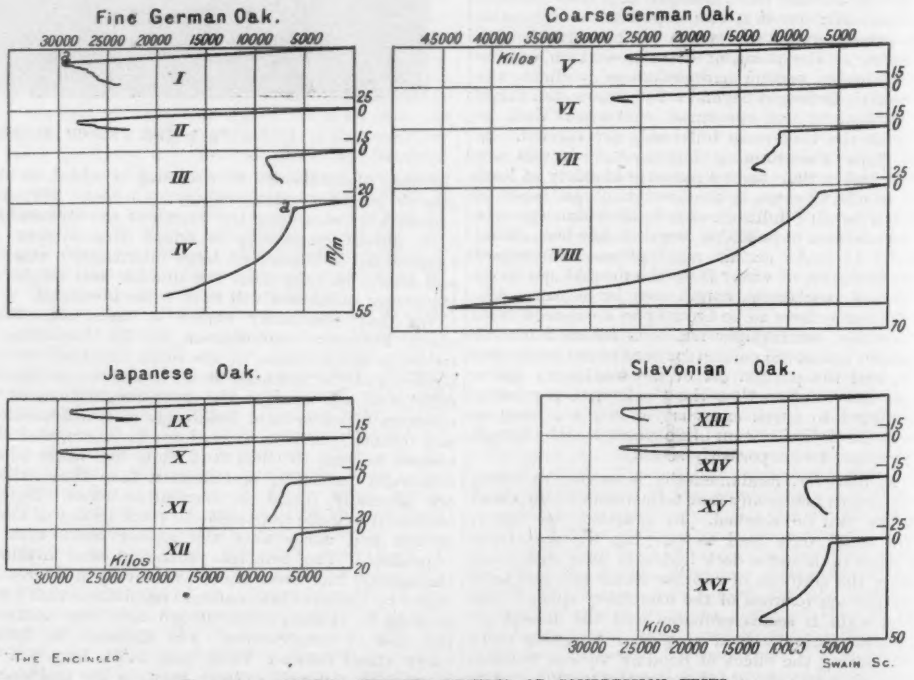
Curve III. differs from the former diagrams owing to the fact that pressure was exerted radially, *i.e.*, at right angles to the annular rings. This diagram shows that the maximum load which the block withstood was considerably less than in the former cases, being only 8900 kilos. This small resistance is due solely to the direction in which pressure was exerted ; it is well known that wood is split most easily in the direction of the medullary rays.

Curve IV. is similar to Curve III., pressure having been exerted tangentially to the annular rings. The block altered in shape at the point *a*, under a load of about 6000 kilos., and was compressed to the extent of only 2½ mm. The maximum load was 19,140 kilos. This test shows that although oak is severely compressed when the pressure is exerted in the direction indicated, it can still resist great loads.

These four tests were made with the same material, namely, fine German oak, and similar tests were carried out with coarse German oak, Japanese oak and Slavonian oak. The diagrams are very similar for the same direction of pressure. It is very interesting to note that in Curve VIII. in the case of coarse German oak tested tangentially to the annular rings, the block withstood a maximum load of 44,240 kilos., and was compressed from 100 mm. to 41½ mm. On comparing these results it will be found that the Japanese oak did not behave at all badly.

### (*b*) TENSILE TESTS.

The same four kinds of oak were tested, but their dimensions were 500 mm. by 10 mm. by 10 mm. They were also well seasoned ready for constructional use. The following table shows their exact dimensions and the results obtained. The fractures show that the parts between the annular rings are in the form of small curls, this being a sign of the mutual displacement of the fibres on being torn apart. It will be seen that Japanese oak and Slavonian oak also gave good results under this test. Some of the results were not quite satisfactory, because the test pieces are not easily made, the difficulty being to cut them in such a manner that, notwithstand-




Figs. 1 to 4—CURVES SHOWING RESULTS OF COMPRESSION TESTS

ing the small cross-section, the longitudinal fibres shall be parallel with the longitudinal axis of the test piece.

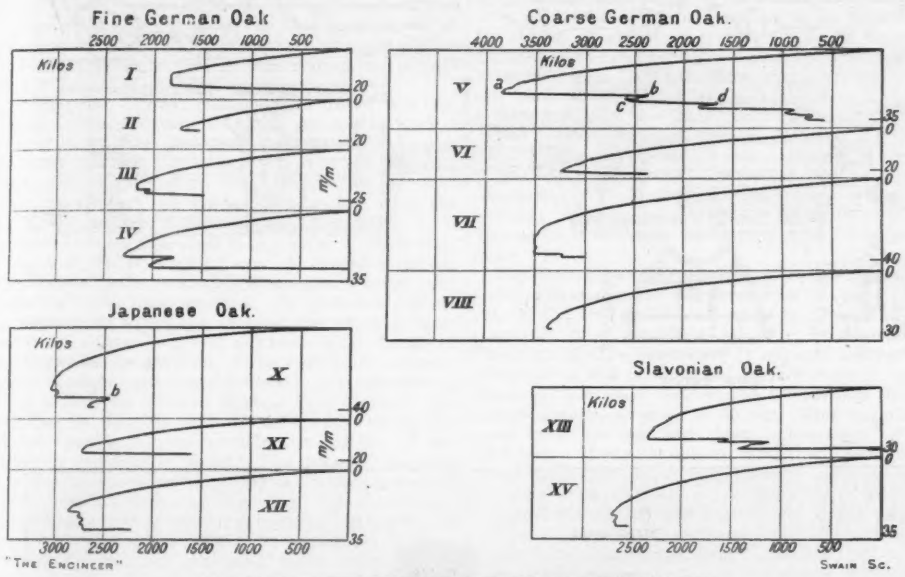
*Tensile Tests on the Tarnogrocki Machine.*

| Test No. | Before the test. Length. | Width. | Thickness. | Kind of wood. | Fracturing load. | Maximum load. |
|---|---|---|---|---|---|---|
| | mm. | mm. | mm. | | Kilos. | Kilos. |
| I. | 500 | 10.1 | 11.1 | D. m. | 355 | 415 |
| II. | 500 | 10.5 | 10.2 | ,, | 835 | 900 |
| III. | 500 | 10.3 | 10.4 | ,, | 1240 | 1285 |
| IV. | 500 | 10.4 | 10.6 | ,, | 1080 | 1135 |
| V. | 500 | 10.5 | 10.5 | D. gr. | 590 | 640 |
| VI. | 500 | 10.1 | 10.9 | ,, | 1235 | 1290 |
| VII. | 500 | 10.2 | 10.4 | ,, | 760 | 815 |
| VIII. | 500 | 9.8 | 9.9 | ,, | 1165 | 1185 |
| IX. | 500 | 10.4 | 10.4 | Jap. | 1070 | 1160 |
| X. | 500 | 10.0 | 10.1 | ,, | 525 | 580 |
| XI. | 500 | 9.9 | 10.0 | ,, | 755 | 830 |
| XII | 500 | 9.2 | 10.2 | ,, | 1550 | 1580 |
| XIII. | 500 | 9.7 | 9.5 | Slav. | 360 | 420 |
| XIV. | 500 | 9.9 | 9.8 | ,, | 365 | 415 |
| XV. | 500 | 9.9 | 9.3 | ,, | 525 | 540 |
| XVI. | 500 | 9.7 | 8.9 | ,, | 450 | 510 |

NOTE.—D. m. = German fine oak; D. gr. = German coarse oak Jap. = Japanese oak; Slav. = Slavonic oak.

### (c) BENDING TESTS.

Again the same four kinds of oak were tested, the dimensions of the test pieces being 800 mm. by 80 mm. by 80 mm. Analysing the four diagrams for coarse German oak, we have:—The abscissa represents the load in kilogrammes and the ordinate the deflection in millimetres. Following the Curve V., Fig. 6, it will be seen that at the point *a* the maximum load of 3870 kilos. was reached, the test piece giving way at this moment with a loud report. From the point *a* the curve returns parallel to the abscissæ until the point *b* is reached, which represents




Figs. 5 to 8—CURVES SHOWING RESULTS OF BENDING TESTS

a load of about 2300 kilos. At this point the test piece is again capable of bearing a greater load until the point *c* is reached at 2600 kilos. Thereafter, the curve returns once more when the resistance of the test piece again increases, and this feature repeats itself. To ascertain the carrying capacity of the wood according to the theoretical moment of resistance, only that portion of the curve limited by the point *a* is of importance. The continuation of the curve is only interesting as regards the quality of the wood, inasmuch as it reveals that the test piece was not immediately broken when the maximum load was reached. Only a portion of the fibres was broken, while the remainder was still solid, so that it could offer resistance to a load of about 2500 kilos. in this case. Something quite different takes place in Curve I., Fig. 5, the test piece being of fine German oak. In this case, as soon as deformation began, the curve returned right to the ordinate. The fracture disclosed that the test piece broke throughout the cross-section, whereas the fracture of the coarse German oak comprised many splinters. Even in this case it was found that the material between the concentric rings had assumed the form of small curls, a sign that to a certain extent the fracture was due to the separation of the fibres, *i.e.*, to their mutual displacement.

Curves VI., VII. and VIII., Fig. 6, are similar to Curve V., but have not been followed beyond the maximum load.

When examining Curve X., which was obtained with a test piece of Japanese oak, it will be seen that here also no complete fracture took place under the maximum load, but that at the point *b* the test piece was still capable of supporting a load of about 2500 kilos. This is a very favourable feature of Japanese oak, and the fractures showed that it possessed great resistance. The fracture comprised many splinters, which is a proof of the fact that under increasing load the splinters separated from one another by a mutual displacement.

It is highly important for oak that it should be felled in winter, otherwise it loses in resistance, and as the felling of oak trees in Japan is only possible in the winter, a guarantee is afforded that only winter-felled trees of Japanese oak reach the market. The oak grows in northern Japan upon hilly ground and under approximately the same conditions both as regards climate and soil as the best European oak trees. The quality of the Japanese wood, its fine growth, its nice appearance, its uniform drying, its susceptibility to treatment and so forth, place it in the first rank with the recognised best kinds of European oak.

Finally, it is highly important to import only such kinds of timber as are free from defects, such as knots and the like. As the strength depends upon many factors—among others, upon the moisture contained in the wood—the permissible load or tension should be only one-eighth to one-twelfth of the maximum load. Many other kinds of timber besides Japanese oak have been submitted to similar tests at the works of the Hannoversche Wagenfabrik, *e.g.*, Jarrah, Bongosi or so-called "iron wood," Bang or African oak, &c.

Of special interest to rolling stock builders are some abrasive tests with sand blast apparatus, carried out by the Hannoversche Wagenfabrik on blocks 50 mm. diameter during a period of two minutes under an air pressure of 30 lb. per square inch.

| Wood. | Depth of abrasion On sectional surface, mm. | On longitudinal surface, mm. |
|---|---|---|
| German oak, coarse (*a*) | 0.44 | 0.95 |
| German oak, coarse (*b*) | 0.59 | 0.73 |
| German oak, medium (*a*) | 0.49 | 0.87 |
| German oak, medium (*b*) | 0.29 | 0.73 |
| German oak, fine (*a*) | 1.21 | 1.34 |
| German oak, fine (*b*) | 1.14 | 1.54 |
| Pitch pine (*a*) | 0.76 | 2.72 |
| Pitch pine (*b*) | 0.76 | 0.82 |
| Japanese oak (*a*) | 0.43 | 0.69 |
| Japanese oak (*b*) | 0.75 | 0.87 |
| Jarrah (*a*) | 0.235 | 0.90 |
| Jarrah (*b*) | 0.26 | 1.17 |
| Jarrah (*c*) | 0.28 | 1.05 |
| Bongosi (*a*) | 0.11 | 0.30 |
| Bongosi (*b*) | 0.09 | 0.45 |
| Bongosi (*c*) | 0.11 | 0.25 |

## THE LEAD CASTERS.

WE fear it is not given to many engineers to see that there is sometimes art, mystery and romance still left in the crafts they pursue. The handling of metals has become commonplace to us, and only now and then does some Ruskin of our trades give us glimpses of the things they mean to an imaginative and inward-seeing mind. We borrow the following passages from a little article by Mr. Paul Waterhouse in *The Builder* of May 22nd. It describes the casting of new lead sheets for the roof of the old church at Lower Daggesden. The work is being done in the church "barn."

"The four Anakim were there—no mere workmen at an episode of their work, but four actors, or, if you will, four priests. They stood round a wooden table. It was long—twice the length of a billiard table, half its width. At one end was a trough, at the other was apparatus of mystic uncertainty. Down each side was a wooden substitute for billiard cushions, and where the green cloth should have been a layer of sand. The sand, when I entered, was, to my eyes, apparently smooth and fine. It was not so to the sons of Anak. With a persistence that was ritualistic rather than technical, they pounded, scraped, and harried its surface, using a special two-handled timber for their purpose. To this pummelling followed "ironing" with flat weapons a foot square, first by two magicians, then by one alone—the leader, the captain, singled out as such not by uniform, not by the utterance of commands—for never a word they spoke—but by a certain majesty of carriage and by a supremacy of hand and glance.

"There followed a lull of movement. All stood aside in the twilight of the barn, and one, the youngest, it seemed, and the tallest, lit, with all the ceremonial of the sanctuary, four oil lamps that hung from the rugged rafters. The roof, playing its part as if the whole building had waited till this hour for its fulfilment, took up the gleam and became a canopy for magic. The expectancy grew.

"Then a voice—the first utterance from the speechless hierarchy—addressed itself to me. Had he said, as I half expected, '*Procul, O! procul este, profani*,' I should have fled. But banishment was not the doom. I was to wait, to witness; but would I stand close—close to the door, for fear——

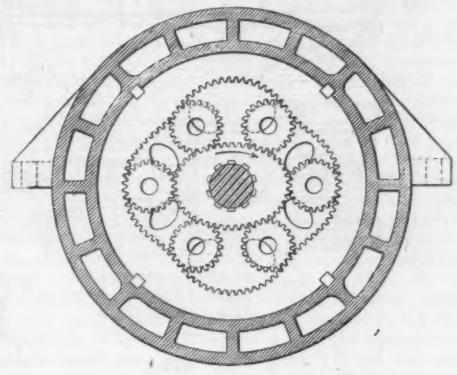
"I did. I ground myself against the door jambs and added my contribution to the five-fold silence. Two of the ministrants stood at the mystery end of the table and were already ladling from a cauldron to a trough. The ladles were incredibly heavy, the trough was filling with what looked like silver, and the ladlers were speechless. But their lips moved. Was it silent incantation or merely counting? I know not. At last another pause—a new expectancy which, from its greatness, was clearly the penultimate strain. And then, suddenly, the unexpected One of the Titans gazed upwards, and leapt—leapt into the air to fling grip and weight on to an uncouth lever improvised among the roof beams. Another Titan added his weight. They bore it down, and with the downbearing came the climax. The trough heaved, and along the length of the billiard table, from bank to bank, like a tidal wave, flowed a flat gush of glittering ooze. The table was covered, the bottom trough received its tribute of overflow, and with the deftness of conjurers, two of the giants scraped the surface of the molten sheet with a gauge that levelled it to a thickness of mathematical certainty.

* * * *

"Thus was cast a sheet of lead, destined, so it is hoped, to shield, with others, for another hundred years the timbers which the men of the fifteenth century wrought for this very lead's upbearing. For it is the same material that goes back on to the roof; and, for aught we know, John Fellowes and Robert Oliver, in the days of King George, only remodelled the metal that had been there since the reign of Henry VI."

## NEW FORM OF ROTARY PUMP.

IN a recent issue—May 7th—of our esteemed contemporary, the *American Machinist*, an interesting and unusual form of rotary pump is illustrated and described. For the benefit of our own readers we here take the liberty of reproducing one of the diagrams accompanying the article. The construction and action of the device will be obvious to most from the engraving. The mechanism consists of a rotatable elliptical gear wheel, an internal geared ring almost square in elevation, and six circular pinions meshing between the ellipse and the square. As the ellipse is



THE DOCK ROTARY PUMP

revolved the space between any pair of the pinions increases from a minimum to a maximum, and then decreases from this maximum to the minimum again. While each such space is increasing it is in communication with a suction port, and while it is decreasing it is in communication with a delivery port. It is stated that the action is perfectly balanced, and that the product of the average flow and the pressure obtained is constant at all deliveries. The device, the invention of Mr. H. Dock, of Westerly, Rhode Island, is also capable of working as a hydraulic motor by using one set of ports for the inlet of the working fluid and the other for the exhaust. A motor and pump combined have been constructed in the form of a variable speed hydraulic transmission. For this purpose the pump portion is in duplicate. The deliveries of the two pumps can be arranged to oppose each other or to assist each other to any extent up to the full maximum merely by moving the relative positions of the internal and elliptical gears of the two parts. In this way variation of the motor speed from zero to the maximum and in both directions is obtained. It is stated that a pump 9½in. in diameter and 2½in. long was recently submitted to a hundred hours' endurance test. It was run at 800 revolutions per minute and delivered an aggregate of 1.1 million gallons of water at an average pressure of 120 lb. per square inch.

## SPECIAL WAGONS FOR WOOLWICH ROYAL ARSENAL.

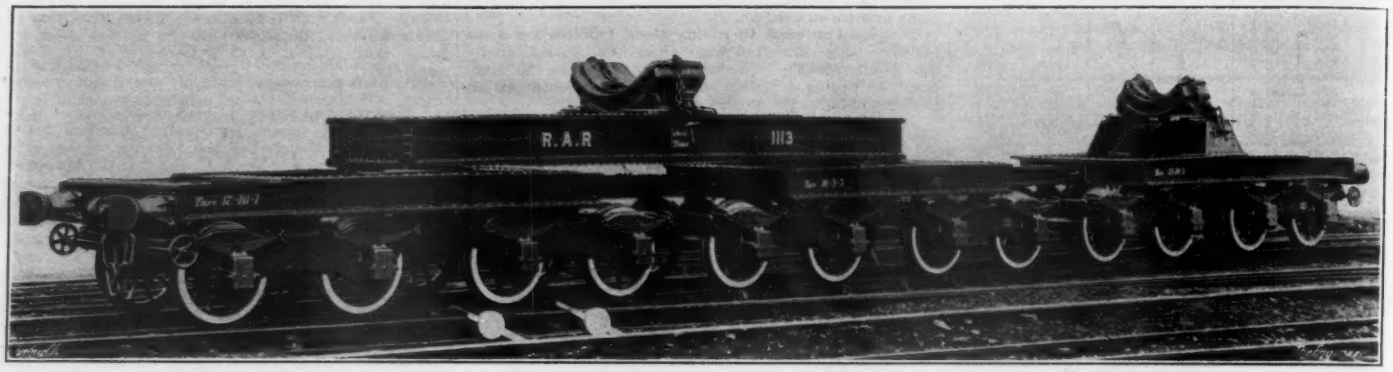
THERE have recently been introduced on the system of railways at Woolwich Arsenal two special types of trucks, several of each of which have been constructed by Hurst, Nelson and Co., Limited, of Motherwell, to the order of the War-office. The first of these two types of wagons is a truck designed to carry guns ranging up to 130 tons in weight. The three sections, each of which is carried on two four-wheel pressed steel bogies, have steel framing, and two of the sections carry a pivoted beam on which one of the supports is mounted, whilst the other support is on the third section. The second type of wagon comprises several tube trucks, which are designed to carry 60 tons each, 40 tons being on one bolster and 20 tons on the other. The gun truck has a length over buffers of 66ft. 3in., a length over headstocks of 63ft. 3in., whilst the tube truck has a length over buffers of 50ft. 1½in. and a length over headstocks of 47ft. 1½in., the bogie wheel base in both types of wagons being 5ft. The other dimensions and detailed constructional features are so clearly set forth in the engravings on page 618 that nothing further in the way of description appears necessary.

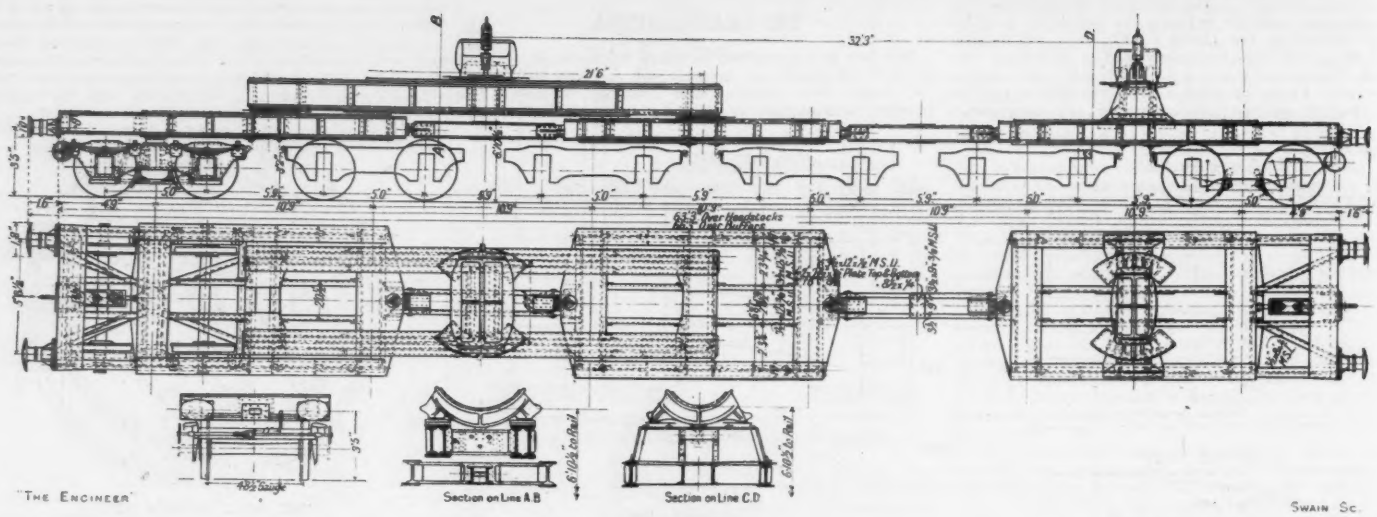
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.—The seventh congress of the International Association for Testing Materials will be held under the patronage of the Czar of Russia in St. Petersburg, from August 12th to 17th, 1915. Four days will be devoted to the discussion of problems on testing materials. Extensive excursions in the interior of Russia have been arranged to take place after the congress. The offices of the British Section of the Association are at the Iron and Steel Institute, 28, Victoria-street, London, S.W.

# SPECIAL WAGONS FOR WOOLWICH ARSENAL

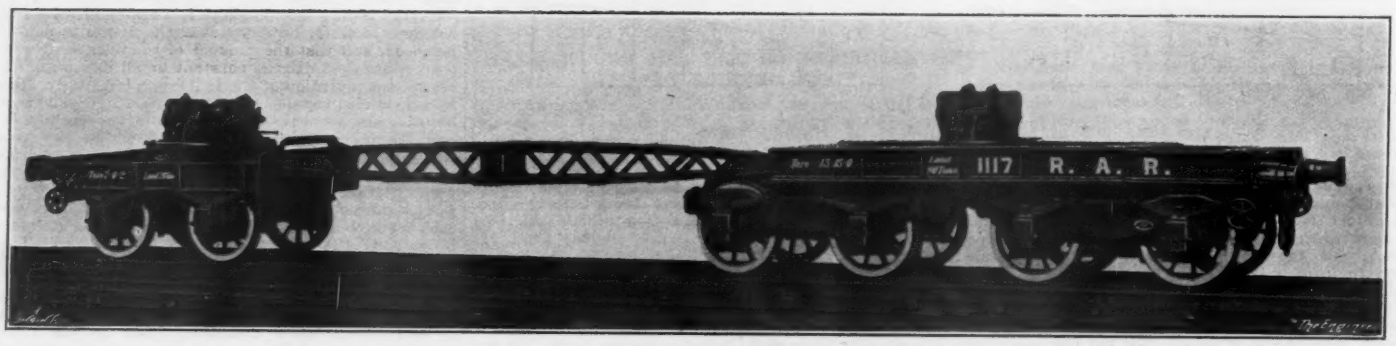
HURST, NELSON AND CO., LIMITED, MOTHERWELL, ENGINEERS

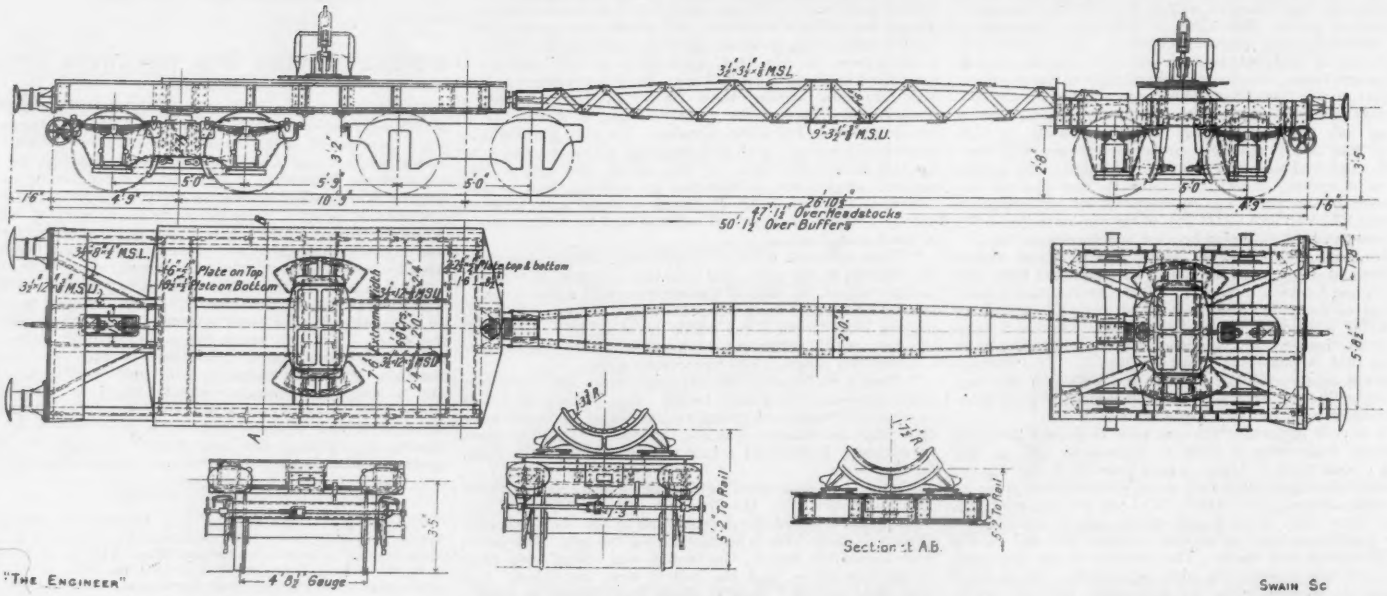
(*For description see page* 617)




GUN TRUCK




GUN TUBE TRUCK

## THE WORK OF THE GOVERNMENT AERONAUTICAL COMMITTEE.

WITH each year it is becoming more and more impossible to present a satisfactory summary of the research work undertaken by, or for, the Advisory Committee for Aeronautics. The report for the year 1912–13, the fourth annual report of the Committee, has recently been issued, and is considerably more bulky than any of its forerunners. It contains over 400 pages and includes, all told, twenty-eight separate reports, one of which is in nine sections, one in five, one in four, and one in three.

It is quite impossible to deal fully with the whole report. All we can do is to indicate its contents and touch briefly upon a few of the more important results.

After the usual summary of the year's work, signed by Lord Rayleigh, the president of the Committee, we find various appendices in which a large variety of technical subjects is discussed, either by way of being accounts of experimental work undertaken at the National Physical Laboratory on behalf of the Advisory Committee, or as memoirs, more or less mathematical, contributed by certain authorities.

Passing over a report on the determination on the whirling arm of the pressure-velocity constant for a Pitot tube, we come to an interesting memorandum contributed by Mr. F. W. Lanchester. This report calls attention to a simple relationship that exists between the skin friction experienced by the surface of a body moving through a fluid and the capacity of the surface for disposing heat to, or absorbing heat from, the fluid. The subject has a distinct interest outside aeronautics and deserves close attention. The argument awaits experimental confirmation and is based on the fact that, as has been understood for some considerable time, the viscosity of a gas and its conductivity for heat may be regarded up to a certain point as identical physical quantities.

Two reports on wind channel work follow, the first dealing with the steadiness of the air flow in such a channel, and the second being descriptive of the new 4ft. wind channel at Teddington and of the weighing mechanism employed in connection with it. The latter mechanism, we gather, is identical with the Cambridge Scientific Instrument Company's aerodynamic balance described in our issue of May 15th.

The next report is a long one. It describes certain experiments made on models of aeroplane wings, and is divided into nine sections. In previous reports the manner in which the lift and the lift-drift ratio varied for a given angle of incidence with change of camber, while the position of the maximum ordinate remained unchanged, was discussed. The first section of the report we are now dealing with discusses the variation of the lift and lift-drift ratio when the camber remains constant, while the position of the maximum ordinate is varied. The influence appears to be very marked, and it is indicated that beneficial results would accrue by placing the maximum ordinate of the wing section somewhat farther to the rear than is customary. The next section shows that, contrary to recently accepted ideas, there is no aerodynamical advantage in thickening the leading edge of an aerofoil, although a slight thickening is not attended by any serious aeronautical disadvantage. A succeeding section shows that the thickness of the aerofoil may be increased within limits in the neighbourhood of the trailing edge without entailing any particular disadvantage. Here, again, accepted ideas are shown to be erroneous, and in this case the demonstration of the error should be of much value to practical constructive work, for it clearly points to the permissible use of deeper spars at the trailing edge than are now adopted.

Three sections of the report are given up to the further discussion of that old question, How do the results obtained from models apply to full-sized wings? It is known that size, velocity, and the nature and state of the fluid should affect the magnitude of the so-called constants in which the lift, lift-drift ratio, &c., are expressed. It is concluded that no serious correction need be made in the case of the lift coefficients, but that from 15 to 20 per cent. should be added to the lift-drift ratios of models to make them applicable to full-sized wings. In another important section of the same report the effect of reflexing the trailing edge of an aerofoil is considered. By reversing the curvature in this neighbourhood it is possible, as already known, to prevent or restrict the movement of the centre of pressure with change in the angle of incidence. It is found that entirely to prevent the movement of the centre of pressure by this means it is necessary to sacrifice about 12 per cent. of the maximum lift-drift ratio and about 25 per cent. of the maximum lift coefficient. In yet another section the effect of warping aerofoils is considered. It was sought to discover whether the effect of warping could be calculated from a knowledge of the lift and lift-drift ratio of the aerofoil when not warped. The results show that the observed and the calculated rolling moments of a warped aerofoil differ very considerably, and that it is not safe to rely on the calculation in the present state of our knowledge on the subject without checking the result experimentally.

A very detailed report, which can only be studied in the original, on the distribution of pressure over the entire surface of a selected aerofoil, then follows. We can only say that the tips of the wing are found to have a very low aerodynamic efficiency, and that research into the variation of camber, angle of incidence, and plan form in the neighbourhood of the tips seems to promise good results. The general features of the research are very similar to those conducted some time ago on the same subject by M. Eiffel.

The succeding report is one of great practical value, for it deals with the wind forces and moments acting on certain parts of aeroplanes. It is in five sections. The first section takes struts as its special subject. It shows that great accuracy in the symmetry of struts is called for. If this accuracy is absent, even though the error is very minute, the drift forces and the cross wind forces produced by the struts when the aeroplane yaws will be very unsymmetrical and erratic—that is to say, the magnitude of these forces will not be the same for angles of yaw equal in magnitude but opposite in sign. The greater the fineness ratio the less effect will irregularities of construction have on the drift and cross wind forces. If this ratio is less than $2\frac{1}{2}$ to 1 the drift will be very high and the cross wind force will probably be very erratic in its magnitude and be directed oppositely to that of a real fin.

In the second section some tests on model aeroplane bodies are discussed. Two of the models were of the bodies of the Royal Aircraft Factory's B E 2 and B E 3 biplanes, and were to a scale of one-twenty-fourth. Two other bodies of a somewhat similar design and one of a wholly different form were also examined. The work is merely the preliminary to an extended research on the forces and moments acting on aeroplane bodies which is at present in progress. The general effect of the experiments described in this section of the report is to show that very considerable improvement is to be expected in the design of aeroplane bodies. A single boom—or something as near to it as is practically realisable—extending from the rear of the pilot's cockpit to the tail planes and elevators seems to be indicated as a desirable development.

The forces and moments on an aeroplane wheel when it is yawed through various angles is studied in the third section. The results present no striking peculiarity. The drift due to each wheel when in its ordinary flight position is stated to be about 2.4 lb. This is for a full-sized wheel moving at 70 miles per hour.

The fourth section of the report describes some tests made on a model tail plane with elevating planes attached. The model was made to a scale of one-sixteenth from drawings of the Royal Aircraft Factory's B E 2a machine. It appears that at any particular speed of flight no further control can be obtained than that represented by turning the elevators through an angle of 30 deg. This angle holds good both for up and down movements of the elevators. It would appear, too, that the moment about the hinges of the wind pressure on the elevators increases approximately proportionately to the angle of depression or elevation, until the limiting angle of $\pm$ 30 deg. is reached. This fact should be of utility in the designing of the pilot's controls.

The fifth section of the report deals with the wind resistance of smooth wires and practically only confirms the results published in the Advisory Committee's report for 1910–11. It would surely have been much more to the point if a research had been conducted into the resistance of stranded cable, for this material has practically displaced smooth piano wire for the controls and stays of most aeroplanes.

A method of experimentally determining the forces and moments on a model of a complete aeroplane is given in the succeeding report, and by way of illustrating its application the results of measurements made on a model Blériot monoplane to a scale of 1 : 20 are set forth. We gather that this is the first of a series of such experiments, the object of which is to enable the conditions of flight at different altitudes and under various circumstances to be fully examined. The experiments are further intended to procure information necessary for the investigation of the stability of the machines.

The next report covers a photographic investigation of the flow round a model aerofoil. The report is illustrated by means of some very interesting half-tone reproductions. Two sets are especially interesting. In one a series of cinematograph photographs taken at the rate of about four per second shows the complete history of an eddy behind a selected aerofoil. The other set shows a similar state of affairs with a half-inch cylinder substituted for the aerofoil. The experiments were made in water, and condensed milk was used to make the motion visible.

The succeeding six reports constitute probably the most important portion of the whole volume. They deal with the stability of aeroplanes, and although they are not all of an experimental nature—some being highly mathematical—they should lead to valuable results in connection with this vital matter. Mr. O'Gorman contributes one of the six reports and deals with the gyroscopic couple produced by rotating engines and propellers. We note that he arrives at the figure of 114 lb.-ft.$^2$ (absolute units) for the moment of inertia of a 100 horse-power Gnome engine and 150 lb.-ft.$^2$ for that of a 9ft. 6in. double-bladed propeller weighing 30 lb. For a complete turn of the aeroplane made in twenty seconds the magnitude of the total gyroscopic couple is given as 324 foot-pounds, while for a sudden use of the elevator sufficient just to lift the pilot from his seat it is given as 330 foot-pounds. These couples are not regarded as serious. They can, it is stated, easily be met by the ordinary means of control, and are much the same as the effect produced by a gust of wind, with this difference, that the magnitude and direction of the gyroscopic couples are known and expected.

A report on experiments with model propellers then follows. In the third of the three sections into which the report is divided some facts of great interest to propeller designers are set forth. It is customary in designing aerial propellers to proceed on the basis that the blades may be considered as divided up into sections, and that each section may be treated separately as a small aerofoil moving through still air with a velocity compounded of the rotational and translational velocities of the propeller at the point in question. It is shown that the method is not strictly correct, and that, on the whole, the calculated thrust, torque, and efficiency will be somewhat less than that actually obtained. It is added, however, that in the hands of a careful designer the theory is probably by far the best that can be used in the present state of our knowledge of the action of aerial propellers. To determine the best angle of attack for the blades of a propeller it has been customary to proceed on the assumption that maximum efficiency will be obtained when the angle of attack of the blades is that angle for which the lift-drift ratio of the blade sections regarded as aerofoils is a maximum. Experiments described in the report do not appear completely to bear out the assumption. Thus a certain propeller should have had maximum efficiency when the angle of attack was 4 deg. It was found, however, that maximum efficiency was obtained when the angle of attack was made 9 deg.

Three reports on strength of construction are next presented. The first is largely mathematical and deals with the methods of calculating the stresses in the spars of aeroplane wings. It goes fairly deeply into the matter and deals with the conditions introduced when one or more of the stay wires break. It seems to indicate that the calculation of these stresses is not by any means the simple affair some would have us believe it to be. The second report deals with the stresses in the wing fabric. It is pointed out that the maximum intensity of loading on the upper fabric may be four times the average loading. In the succeeding report Mr. O'Gorman describes experiments made on a wing of a B E 2 biplane in the light of this knowledge. It is found that the upper fabric easily bears the quadrupled load. When the wing fabric was tested to destruction it was found that the means of fastening the fabric to the ribs gave way long before the fabric itself showed signs of failure. As a result an improved method of fastening the fabric has been evolved, and in the report a description of this method is given.

Next we have two reports on hydro-aeroplanes. Both deal solely with the design and performance of floats for these craft. The second report is an account of some work done on the subject in the William Froude tank at Teddington, and as an appendix to it is added a report on the wind forces acting on hydro-aeroplane floats as determined in wind channel experiments.

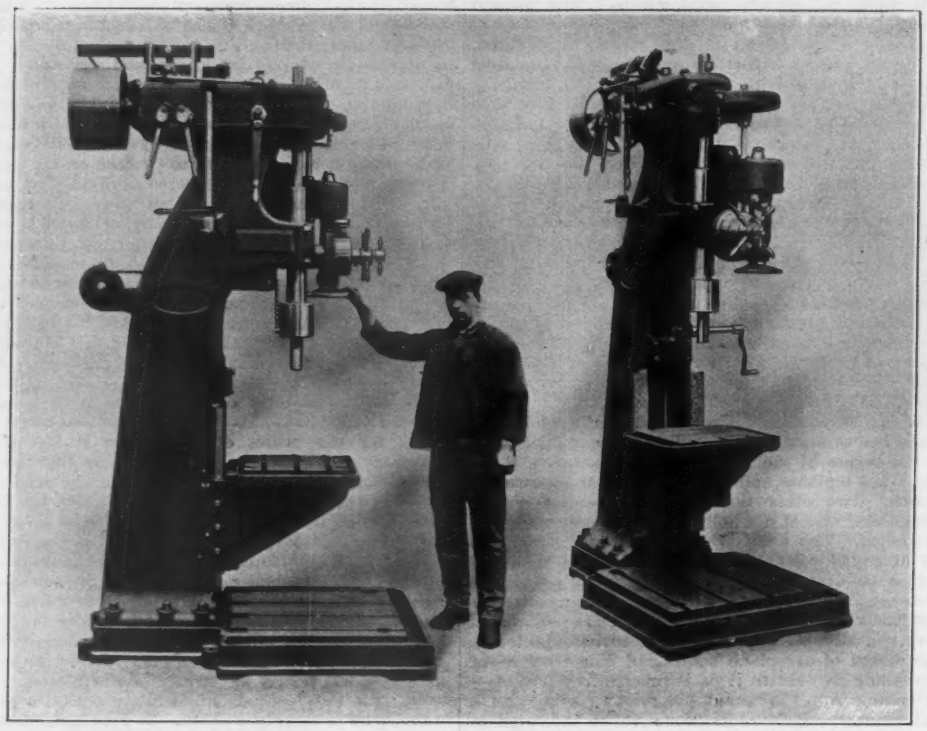
A report on the work of the Royal Aircraft Factory for the year follows and makes interesting reading. Its value, however, is somewhat detracted from by the fact that it covers the period March, 1912, to March, 1913, so that the information it contains relates to events which took place fifteen to twenty-seven months ago. Experiments on balloon and aeroplane fabrics are described in the succeeding report, after which comes Dr. Rosenhain's annual report on light alloys; while, finally, we have the usual meteorological report on wind structure.

## DUST ON UNDERGROUND RAILWAYS.

THE convenience of the underground railways in Paris is greatly appreciated by the public, but those who employ this method of transport have, nevertheless, plenty of reason to complain of the vitiated character of the air in the Metropolitan, although, singularly enough, the air in the Nord Sud appears to be remarkably free from dust. Everyone experiences great relief in passing from the Metropolitan to the transversal line. The Conseil d'Hygiène so far considers the dust of the Metropolitan as detrimental to health that for two years past experiments have been carried out in the municipal laboratory, and the results of these tests have been incorporated in a report which shows that, while air taken from the Metropolitan gives 134 milligrammes of dust, air from the Nord Sud contains only 6 to 16 milligrammes. The principal cause is attributed to the rails. On the Metropolitan the wear is very pronounced in the stations, where they are corrugated by the effects of braking. On the Nord Sud the rails are apparently harder steel, and in the stations they show little signs of wear. Again, the brake shoes on the Metropolitan are of cast iron, and on the Nord Sud they are faced with a tar-treated fabric. An incidental result of this practice is that the Nord Sud trains stop much more smoothly, and are in every way more silent than the Metropolitan trains. The report also refers to the difficulty of sweeping the floors of the Metropolitan coaches, which are of wood crossed with narrow strakes. On the Nord Sud the floors are covered with a conglomerate material forming a uniform and non-slipping surface. It is therefore proposed that the Metropolitan should follow the practice of the Nord Sud alike as regards

## VERTICAL DRILLING MACHINE

WILLIAM ASQUITH, LIMITED, HALIFAX, ENGINEERS



the use of harder rails, brakes lined with fabric, and the covering of the coach floors with a uniform material which can be cleaned with wet sawdust. It is also proposed that the ballast in and near the stations should be covered or replaced by tiles to permit of dust being easily removed. The laboratory tests are to be continued to ascertain the influence of the dust upon public health, and it is only when these are completed that official representations will be made to the companies to suppress what is regarded as a serious danger.

## HIGH-SPEED VERTICAL DRILLING MACHINE.

In addition to its well-known vertical drilling machines for extra heavy duty, the firm of William Asquith, Limited, of High Road Wells, Halifax, has recently placed upon the market a series of machines which, while somewhat lighter in construction than their forerunners, are still designed for the high rates of drilling speed now in vogue. One of these machines is shown in the accompanying illustration, which gives two views of it.

As will be seen, the main body is made with a good strong section, and it is ribbed internally and provided with a wide base for bolting to a foundation or to a working bed-plate. On the front of the body working slides are arranged to form a bearing for the vertical adjustment of the table. As shown in the engraving, the table has only vertical motion by means of a hand lever and bevel gear, but if required a table which can be swung out so that deeper work may be secured to the working bed-plate can be supplied. Usually when the table is made not to swing out the bed-plate is not provided.

The top of the body has a seating for receiving the gear-box and for forming the drill head. The gear-box is of the firm's standard type. It enables eight or twelve changes of speed—according to the size of machine—to be obtained with a constant driving belt speed. The spindle is balanced by a compensating spring and is provided with quick and fine hand adjustment with four changes of self-acting feed. The thrust upwards and downwards is taken by ball bearings.

The work table, of what is known as the 36in. vertical machine, measures 2ft. 6in. by 2ft. and is of the plain type with no compound adjustment, but capable of up-and-down movement; but other types of table can be supplied. For instance, the table can be arranged at a fixed height, or the machine can be fitted with a compound table 24in. long and 30in. wide, with a longitudinal traverse of table of 20in. The machine can also be supplied with an automatic trip motion for the repetition drilling of holes of equal depth.

The various particulars of the machine which is known as the 24in. vertical machine are as follows:—The diameter of the spindle in the driving part is 2in. and the spindle traverse is 12in. The eight spindle speeds vary from 480 to 43, and the machine will drill holes up to 2in. diameter out of the solid at the highest speeds and 2¼in. or 2½in. holes at lesser speeds. The four-spindle feeds vary from 120 to 32 cuts per inch. The maximum and minimum distances from the top of the table to the spindle are 2ft. 3in. and 1ft. respectively. The work table in this machine measures 18in. square and the approximate weight of the machine is between 19 cwt. and 20 cwt. This size of machine has, under test, drilled a 1¼in. hole in steel at the rate of 6in. per minute, the speed being 180 revolutions and the feed 32 cuts per inch.

The leading particulars of the 36in. machine are as follows:—The diameter of the spindle in the driving part is 3in. and the length of the spindle feed 15in. The four-spindle feeds are 120, 80, 43, and 32 cuts per inch, and the twelve-spindle speeds 358, 293, 241, 196, 150, 117, 97, 78, 62, 50, 41, and 33.5 revolutions per minute. The driving pulleys are 4½in. wide and 14in. diameter. The spindle is bored to No. 5 Morse taper and the maximum distance between it and the work table, which measures 2ft. 6in. by 2ft., is 24in. The approximate net weight of the machine is 45 cwt.

## GROWTH OF THE AMERICAN ELECTRICAL INDUSTRY.

*(By an American Correspondent.)*

Advance figures of the United States quinquennial census of central station companies have recently been given to the technical Press, and their comparison with the data for 1902 and 1907 is full of interest for electrical engineers.

The English electrical industry is probably in a healthier condition now than it was three or four years ago, and much enterprise has recently been shown by central station managers in various sections of the country in developing latent possibilities in the markets to which they are catering. The resulting growth of the British energy supply business is creditable enough; but it must be admitted that it fades almost out of notice when reckoned in terms of American electrical progress. It is established beyond question that the central stations of the United States, operating in even the most densely settled parts of the country, are acquiring new business at a steady rate of around 12 per cent. per annum. A decade ago it was about 20 per cent. That pace could hardly be maintained indefinitely; but it is significant that between 1907 and 1912 an increase in gross earnings of 71 per cent. for the whole country was registered, equivalent to a straight line 14 per cent. every year.

It is believed that there are lessons in all this for the English electrical man. If all the American expansion had been simply the natural accompaniment of a rapidly expanding population, or if it was confined alone to the frontier Western States, it might be said that no country in the Old World could hope to emulate the results which were being achieved. Actually that is far from being the case. Population would account, at the most, for 2 or 3 per cent. in any part of the country, and the rate is greatly in excess of that. And when we reckon the expansion in terms of geographical distribution we find that the older sections of the country are in the very van of progress. The North Central States—a group which includes such territory as New York, New Jersey, Pennsylvania, Ohio, Illinois, Indiana, Michigan, and Wisconsin, fairly comparable with any manufacturing belt in Britain or France—show an increase in gross earnings from 96,800,000 dols. in 1907 to 165,000,000 dols. in 1912, or 14 per cent. per year; while the figures for the South-Eastern States—including the cotton belt, and embracing plenty of old colonial country in such States as Virginia, the Carolinas, and Georgia—show that the gross earnings increased in the same time from 8,260,000 dols. to 17,175,000 dols., or 21 per cent. per year. In the Rocky Mountain States and the Pacific Coast States, on the other hand, the registered increases were but 13.2 and 12.6 respectively.

The census takes us up to the year 1912. The gains are being well maintained. The writer has had access to monthly figures which are being collected now by the *Electrical World*, of New York City; and from them it is quite evident that an annual expansion coefficient of from 10 to 15 per cent. is being realised at the present time. It is very remarkable that such should be the case, but it is undoubtedly true. Rates for service in various parts of the country are coming down; labour costs are steadily mounting; taxes are increasing by leaps and bounds. Everything that the companies have to spend money on is costing them more; and yet we find a regular growth of net earnings, and a punctilious satisfaction of dividend requirements. A heavy increase in gross is the only possible explanation; and this increase in gross—sufficient to offset all the mounting expenditure—is indeed forthcoming. New loads are being tied into the urban systems at a rate which represents a year-to-year increase of around three million dollars a month. And the question arises: How is it possible to raise all the capital which alone can make this wonderful expansion possible?

It must be admitted that the outstanding problem before the American central stations is simply a financial one; but it is gratifying to find that this condition is fully recognised, and that the industry is in excellent shape for meeting the needs of the times. The British electrical industry could never find the money. But then the British electrical industry has been built up on a basis radically different from that which was laid down in America. Which is the better method we will not discuss; but it is safe to say that the industry in America will meet its financial requirements easily and adequately, because the matter will be plainly put up to private capital. The life of the industry depends solely on private capital; government, whether municipal or otherwise, has nothing at stake. A private operator, with ten million dollars of utilities on his hands, has a very great deal at stake; but, however tight the money market may be, he will give himself no rest in raising such funds as may be necessary for the adequate maintenance of his properties and the adequate extension of his lines. If he can see the chance of making 10 and 20 per cent. on his money he will go ahead with his financing, and some community or other will be the better off in consequence.

So the business grows. The new business can be secured with efficient management. With the new business coming in a most attractive percentage can be offered on the bonds, and a very sporting chance can be given to the holder of the junior issues. If he will practise the diversity rule, a man with a few thousand dollars to invest can net as high an income and enjoy as great a degree of security in the public utility field as he can possibly obtain in any other kind of investment; and while this happy state of affairs continues no overwhelming difficulty will be experienced in finding new capital. The wherewithal will thus be provided for going after and obtaining the new business which alone can justify the investment.

It has been closely figured that every dollar of new business secured calls for the investment of five and six and seven times that amount of money in the property; and therefore, if three million dollars worth of new business is taken on by the central station companies every month, approximately twenty million dollars of new capital must be raised every thirty days. Could it be done, anywhere at all, if the success of the venture depended on anything but the private risk of private money?

## LETTERS TO THE EDITOR.

*(We do not hold ourselves responsible for the opinions of our Correspondents.)*

### REINFORCED CONCRETE BUOYS AND SINKERS.

Sir,—I read under "Notes and Memoranda" in your issue of May 8th that "a concrete buoy has been constructed at Kingston. . . ." One is allowed, I think, to infer that you believe this to be the first ferro-concrete buoy constructed, and I think you are probably correct. The idea of such a buoy must, however, have occurred to many engineers, and I myself made calculations and drawings two years ago which conclusively proved to me that, in certain situations and under certain conditions, ferro-concrete might be used.

Will you permit me to describe a similar "construction" I have in hand at the present time, which when floating in the water is to all appearances a concrete buoy, yet is destined to take the diametrically opposed part of the mooring scheme, viz., that of the sinker? A mooring scheme in which I am at present interested demands sinkers weighing 15 tons each, and the circumstances are such that these should be laid without the aid of floating plant beyond a couple of rowing boats. It is owing to these conditions, which are not uncommon, that I have been prompted to design a floating concrete sinker. The details of the sinker are as follows:—External diameter, 8ft. 6in.; height, 4ft. 6in.; thickness of walls, partitions, floor and roof, 3in.; weight of sinker, 5 tons 5 cwt.; draught when floating, 3ft. 3in.; freeboard, 1ft. 3in.; effective weight when scuttled, 3 tons, approximately; effective weight when scuttled and loaded with scrap iron, 15 tons, or less according to requirements. The sinker has eight compartments, each of which is provided with a manhole in the roof. The eye-bolt projects through the top only, it not being necessary to have an attachment on the underside as in the case of a buoy.

The manufacture of this hollow block is performed in some convenient place on shore, from where it may be launched or rolled into the water when properly hardened, it being then towed to the desired spot for sinking. The mooring chain and buoy having been connected to the sinker, water is allowed to find its way slowly into all the compartments by means of plug and vent holes provided, and the sinker gradually settles down into its place. The wooden manhole covers are then removed by diver, and the eight compartments loaded with scrap iron until the necessary weight be obtained.

I cannot conceive that any other material than ferro-concrete would answer the purposes of this scheme, but I am inclined to think that ferro-concrete buoys will never find much room for employment, owing chiefly to their excessive weight and liability to fracture through shock.

Les Falaises, par Bougie, Algérie, May 26th. H. Blake Thomas.

Institution of Gas Engineers.—The annual general meeting of the Institution of Gas Engineers will be held in Liverpool on the 16th, 17th, and 18th inst. On Tuesday, the 16th, the members will be welcomed in St. George's Hall by the Lord Mayor of Liverpool, and after the transaction of the usual business matters, will hear the reports of the Institution Gas Research Fellows. In the evening there will be a reception at the Adelphi Hotel. On the Wednesday there will, first of all, be the annual general meeting in connection with the Benevolent Fund, and afterwards a lecture by Dr. Charles Carpenter on "Purification by Heat: A Century's Progress and its Lessons," which will be followed by a paper by Mr. B. K. Schieldrop on "Some Special Features in Gasworks Practice from Norway." In the evening there will be a reception in the Town Hall. On the Thursday the following papers will be read and discussed:—"Calorific Power as a Standard," by Mr. Jacques Abady; "The Application of Coke Ovens and 'Otto' Direct Ammonia Recovery to Gasworks' Requirements," by Mr. George T. Purves; and "Lime and Sulphate of Ammonia as Fertilisers and how to Increase their Sale," by Mr. John West. Various excursions have also been arranged in connection with the meeting.

## RAILWAY MATTERS.

THE first of the ten passenger express locomotives ordered by the South-Eastern and Chatham Railway from Germany will, we understand, be put in service during the next few days. It will probably be employed on one of the continental express trains between London and Dover. Five of the ten engines have been delivered to the locomotive shops of the company at Ashford and are there being assembled.

THE Khojak Tunnel in Beluchistan, with a length of 2 miles and 769 yards, is the longest railway tunnel in Asia. It is on the Chaman extension of the Sind-Pishin section of the North-Western Railway of India. This extension was built between the years 1888 and 1891 in consequence of the fear of Russian aggression. The tunnel pierces an historic pass across the Khwaja Arman off-shoot of the Koba-Kakar Mountains. Two lines of the Indian 5ft. 6in gauge are laid through the tunnel, which is, like most of the tunnels on the north-west frontier of India, guarded at each end by strong iron gates.

THE plans for the first railway in Iceland are now being worked out. The line will be of narrow gauge and will run from Reykjavik, the capital, through the Thingvalla district—the most fertile portion of the island—to Rangavalle, a distance of about 64 miles, with a branch to the port of Eyrarbakki, an additional 12 miles. The territory which it will serve is very hilly, but since the line is to be built quite cheaply the boring of tunnels will be avoided wherever possible. There will have to be a great many bridges, therefore, crossing the many streams. These bridges will have to be exceedingly strong, because during summer many of the rivers are raging torrents. The entire cost of the line is estimated at £192,600 or about £2688 per mile. The station at Reykjavik will cost but £2800.

AN interesting experiment, with the view of preventing overcrowding, was tried by the District Railway Company on the train leaving Ealing Broadway for the Mansion House at 8.50 last Thursday morning. With the constant growth of passenger traffic, not only has the number of trains been increased, but their length has been extended. An extra coach, reserved for through passengers to the Mansion House only, was added at the rear of the train. As the train was too long for its full length to be drawn up at the platform of most of the intermediate stations, the last carriage stopped in the tunnels at the entrance to the stations. A special guard was attached to the coach which was labelled "Mansion House only." If the innovation proves a success it will probably be considerably extended.

A MOVABLE platform extension intended to increase the safety of passengers leaving or entering the trains in the New York City subways at stations built on curves has been recently tried and found satisfactory. It comprises a grating which slides out from the underside of the platform, and up to the car door, together with a pair of air cylinders, operating levers and control magnets. In the general scheme of operation the platform guard takes his stand at the point where the forward end of the train is expected to stop. Just before the first car comes to rest he moves the controller to the operating point where the magnetic valves admit air to the cylinders, and the grated segment of the station platform moves out as the train comes to a standstill. This platform segment moves in a level plane so that when it moves outward the natural movement of the passengers is not affected in any way. It remains out until the train has proceeded some 7ft. or 8ft., when it is pushed back by the car. This action reverses the electro-pneumatic cylinder control and causes the grating to be drawn farther back and out of the way.

IN view of the almost absolute cleanliness associated with porcelain and like surfaces, states the *Railway News*, a suggestion has been advanced by Mr. W. Hales Turner, of High Elms, Lennox-road, Gravesend, that the present absorbent wood and iron-built carriages should be replaced by steel and porcelain construction, non-absorbent materials which will not carry germs and bacilli. Steel-frame coaches should be used, with panels of plate porcelain for floors, partitions, ceilings, &c., aero metal door and window frames, rust-proof steel laths for strength of the floors, and asbestos copper-coated tape for joints. The upholstering to be movable, so that it can be properly fumigated in the compartment. The use of porcelain is ideal, in that the whole train can be washed inside and outside. A steel frame and porcelain vehicle can be washed out easily once a week or when necessary with carbolic acid or any other disinfectant. Rules and regulations, maps, names of stations, notices, &c., may be burnt in under the glaze and the smooth hard surface impervious against mischievous alterations. Similar methods may also be utilised for station buildings, with porcelain panels glazed and decorated on both sides with the advertisements burnt in under the glaze.

INVESTIGATIONS into the cause and effect of an accident which occurred recently on one of the leading American railways has, according to the *Railway Gazette*, resulted in the production of some interesting data relative to the stresses entailed upon a six-span truss bridge by the passage of a train, one of the cars in which had become derailed. After this derailment the train ran almost across the bridge before it was stopped, so that the derailed vehicle was on the centre of the second span from the east end before it came to a stop, at which time the car became uncoupled and the rear end of the body fell on to the rails. Later, a passenger train was just leaving the bridge when the latter collapsed, throwing the locomotive down the bank and stopping the train suddenly, and the second span from the east end was thrown off its bearings on the pier and the other spans gave way very slowly. Following the accidents, stress sheets were prepared showing the load caused by the heavy engine of the goods train when traversing the bridge with the derailed refrigerator car, and also those caused by the passenger train. From these stress sheets it is seen that the load occasioned by the passenger train was less, the unit flange stress under the loading at the time of the accident being 9000 lb. per square inch in the stringers and 10,100 lb. per square inch in the floor beams, as compared with 10,500 lb. and 11,100 lb. respectively with the goods locomotive. The shearing stresses were likewise less.

## NOTES AND MEMORANDA.

ACCORDING to the *Electrician*, a series of experiments on the variation of skin resistance to the passage of electric currents through the human body have been carried out by Professor von Pfungen, of Vienna. The experiments proved that habits of strict sobriety appreciably lessened the danger of fatal injury from an electric shock. Nervous excitement of any kind lowered the protective power of the skin to a remarkable extent. The measurements were made by means of a sensitive galvanometer, the current passing through the body of the subject from one hand to the other.

MR. TRYGVE D. JENSEN, of the electrical engineering department of the University of Illinois, has for the past two years been making a special study of irons with reference to their magnetic qualities. The aim has been to secure an iron of high permeability and small hysteresis loss and an iron four times more efficient than any now in use has been secured. A vacuum furnace was used for melting the iron, the pressure in the furnace being reduced to about $\frac{1}{2}$ cm. of mercury. Pure iron, when melted in the open air, will absorb a quantity of carbon and oxygen and so be of inferior quality, while iron melted in a vacuum does not absorb any of these elements but remains pure. Various methods were used in cooling, tests being made to determine the effect of cooling slowly, plunging in brine, in liquid air, &c., each iron being tested to determine the magnetic qualities, metallurgical composition, chemical composition, strength, and critical temperature. Much valuable information has been gained by these experiments, the results of which are soon to be published in the form of a bulletin by the engineering experiment station of the University.

THERE appears to be no limit to the possibilities of cinematography. A further stage in its development has now been reached, and recently in Birmingham there was witnessed for the first time in this country a cinematographic demonstration in broad daylight. Educationally, the progress of cinematography has not been as rapid as from the point of view of amusement, and schools and universities have not had its full benefit simply because demonstrations could only be given in a darkened room, necessitating considerable initial expense. Daylight cinematography was first introduced by a German, and he claims that the principal advantage of the invention is that while a lecturer delivers his discourse, students can take notes of the points he makes. Moreover, it does away altogether with artificial lighting. The pictures are projected on the screen from behind, the apparatus being identical with that in common use. It is the screen, however, that is the secret of the whole thing, and its composition is said to be known only to the inventor. It resembles parchment, is fire and weather-proof. The pictures are said to be clear and steady, and not in any way dulled by the strong light of day.

THE *Electrical World* of May 9th and 16th gives a full description of a power station which has been built by the Lehigh Coal and Navigation Company to utilise refuse coal for which there is no market. The company turns out annually enough anthracite coal refuse to maintain in continuous operation generating plant of 100,000 kilowatts; the present installation is 30,000 kilowatts, but untimately it will be increased to the former figure. The boilers are arranged in a single row beneath the railway track, on which 50-ton standard gauge cars run, dumping their contents into bunkers holding two days' supply of coal. Ashes are removed by running railway trucks into the basement under the ash hoppers. The low grade of fuel employed necessitated the use of special grates and combustion chambers. Eight double-ended Babcock and Wilcox boilers are installed, each having four grates; the boilers are of the five-drum bent-tube type, with superheaters. Six of the boilers are fitted with hand-fired grates, 12ft. by 8ft., making a total grate area of 384 square feet. each boiler. The other boilers have mechanical stokers. Details of the grates are given in the article, as well as other novel features, such as sliding furnace doors, double fire arches with air spaces between, &c.

IN a discussion on "Current Limiting Reactances on Large Power Systems," Dr. E. Rosenberg said that in the early days of electrical engineering there was no need for artificial reactance. The generators regulated badly, and it was difficult to maintain the voltage with full load current. The same problem occurred with transformers, which were built with considerable leakage between high and low-tension windings, causing a great drop on the low-tension side, with a constant voltage on the high-tension side. Also a considerable voltage drop occurred in the cables. The regulation of generators, transformers and cables had been improved and safeguards had been introduced which added possibilities of new trouble. For the present, no doubt, these additional reactance coils were necessary in order to limit the effects of short-circuits; but they had not come to stay. Reactances had previously been introduced for paralleling alternators, but design had improved so as to dispense with such additions. Generators were now built which could withstand the effects of short-circuit—not necessarily any number of shorts. The cumulative effect would arise not only on the end connections, but under certain conditions in the rotor, especially if excited from bus-bars with considerable resistance in series. Transformers were now designed to stand dead short-circuits. Extremely close regulation had been done away with by increasing the internal impedance from 1 per cent. to about 4 per cent., and the short-circuit current had consequently been reduced from about a hundred times to twenty-five times normal. Additional reactance in the line was necessary because present-day cables had such an extremely low reactance, and it was to be remembered that before the advent of three-core cable people used single-core cables, and the possibility remained of getting a feeder with a moderate amount of inherent reactance by using either single-core cable throughout or a combination of single and three-core. Of course, the iron armouring in the manner adopted for direct-current single-core cables would not be used, but the problem of effective sheathing could be solved. A natural reactance would then be obtained, also increased safety between phases.

## MISCELLANEA.

THE Isle of Wight Rural District Council recently decided to send to the Admiralty a protest against the high speed of the warships and large liners passing up and down the Solent. The wash sent in by these vessels, it was stated, greatly increased the already alarming erosion of these shores, and in many cases children playing on the shore had narrowly escaped being washed away.

THE text of the Model General Conditions of Contract, issued by the Institution of Electrical Engineers, was formally adopted by the council of the B.E.M.A. at a meeting held on the 21st ultimo; and, as a consequence, will be used by members—in substitution of the Association's conditions—in respect of tenders to municipalities, district councils, public authorities, and in respect of all publicly advertised contracts where full general conditions are issued.

EXPERIMENTS have been carried out at Toulon with a new type of diving bell invented by an Italian engineer. The bell is fitted with hammers, tongs, and other tools, fastened to the outside of the bell, but capable of manipulation from within the bell. The inventor had a narrow escape from death when testing his bell. He had descended to a considerable depth, when the bell became entangled in some rocks, and half an hour elapsed before he could be released from his dangerous situation.

IT is reported that an information bureau has been organised in Hamburg, for the purpose of providing expert information on technical subjects of all kinds, free of cost, with a view to the advancement of the German manufacturing industry. At the "German Expert Office" a number of technical experts, who are also accomplished linguists, are employed, and catalogues, records of works carried out, particulars of new inventions, &c., are stored there. The scope of the bureau appears to be very wide, and it will no doubt be of great assistance to German industry. The *Electrical Review* points out that a similar office in this country, which might be attached to the Commercial Intelligence Department of the Board of Trade, would be no less effective in promoting the welfare of British industry.

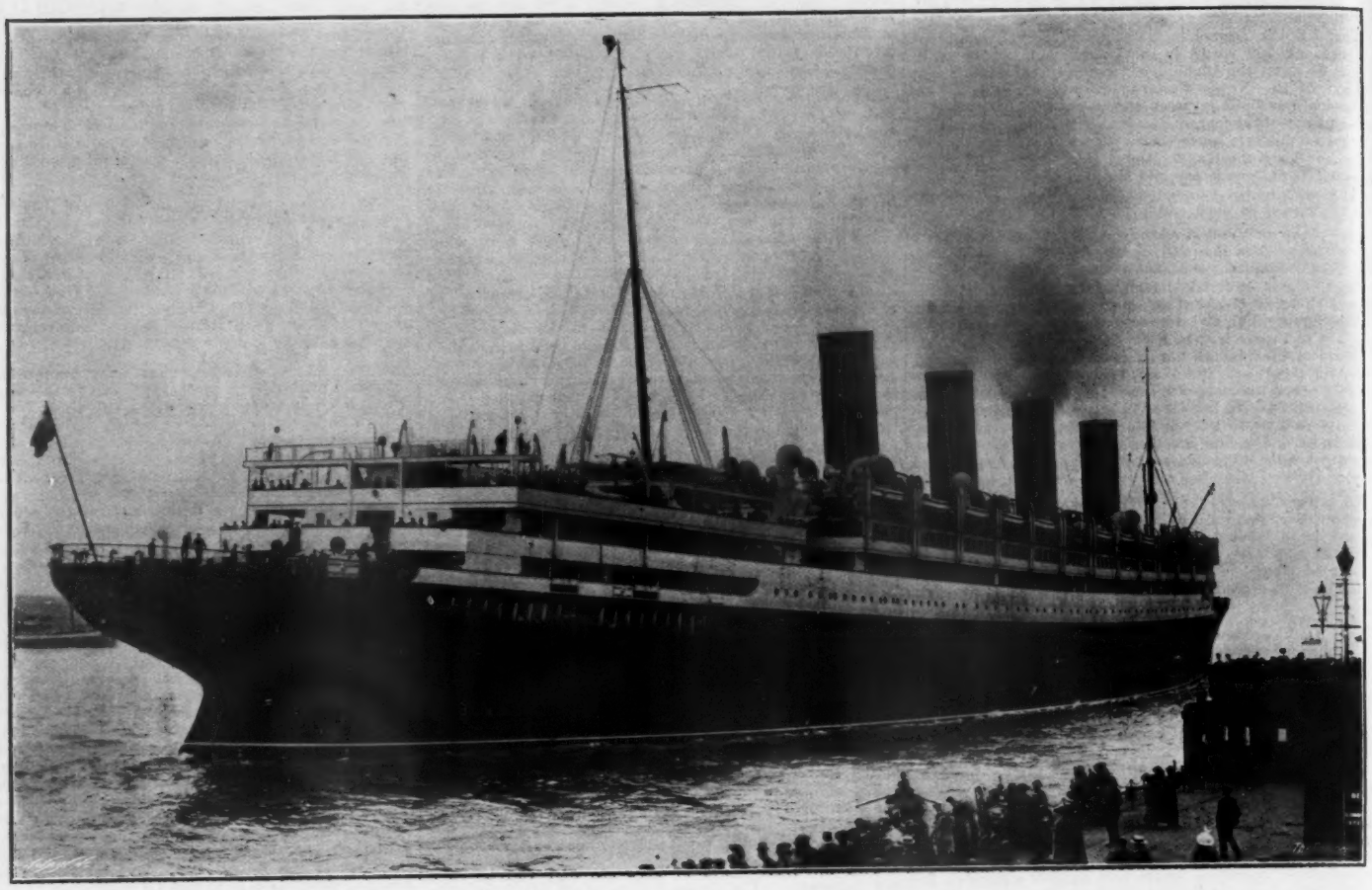
A MEETING of the Electric Vehicle Committee was held in Birmingham on May 22nd, 1914, under the chairmanship of Mr. R. A. Chattock. Sample charging plugs, fitted with earth connection contacts, were inspected and a particular design selected for standardisation. Particulars of this will be given later when all points in connection with the plug have been settled. Further consideration was given to the method of gripping the flexible cable to the plug and the connecting of the earth wire to the plug shell. Final decision in these matters has been deferred, pending the preparation of a new drawing. As to the position of the plug receptacle on the vehicle, it was decided to recommend that it should be fixed under the driver's seat, preferably with the plug pointing upwards so as to make it impossible for the driver to take his seat without noticing that the charging connection is attached to the vehicle. Cases were mentioned to the committee where serious damage had been caused by a driver starting his vehicle away without disconnecting the charging plug—the connection for the latter being placed at the rear or at the side of the vehicle.

A RECENT article in the *Elektrotechnische Zeitschrift* deals with the developments of the Berlin Electricity Works and discusses the best policy for the future. The Berlin municipality is faced with the alternatives of taking the plant over or renewing the concessions of the Berlin Electricity Works under new conditions. At present the city of Berlin gets about one-half of the total net income derived from the plant. The development of the electricity works has been steady, as has also been the increase in the net income. This is shown by the form of the curves extending over the last twenty years. On the other hand, the dividends paid have fluctuated from 1890 to 1912 between 7.75 per cent. as a minimum and 13.5 per cent. as a maximum, and were 12 per cent. in 1911. The stock quotations have been subject to still greater fluctuations. The question of erecting a very large generating station in the Bitterfeld lignite district with a transmission line to Berlin, is considered. The author thinks that in Germany better economic results have been obtained with municipal stations than with privately owned stations. He is in favour of the project that the city of Berlin should take over the electricity works. If, however, the city should decide in favour of giving a new concession, the prospects are that in the future there would be a combined municipal and privately owned management. But the author thinks that in this case the old management, having an experience of many years, would be practically in control.

IN an address which was reported in a recent number of the *Electric Railway Journal*, Mr. S. Insull, president of the Commonwealth Edison Company, Chicago, said that the centralisation of power supply was essentially a monopoly on purely economic grounds, for it conserved capital, labour, and the prime sources of power with the best possible results to the user and producer. He believed firmly that power generation and distribution should be a monopoly, but also that it should be regulated by the State. In the Chicago district centralisation had been brought to such an efficient standard that the charges for service compared very favourably with the much-vaunted cheapness of hydro-electric rates. From curves showing the relative growth of investment and output, it appeared that the Commonwealth Edison Company had increased its business from a sale of 60,000,000 kilowatt-hours in 1903 to 840,000,000 kilowatt-hours in 1913. Another proof of the efficiency of centralised supply and of the technical improvements made in recent years was the reduction in the amount of coal required per kilowatt-hour from 6.93 lb. in 1902 to 2.87 lb. in 1913, with the possibility of another 30 to 35 per cent. reduction. The income on the capital invested had increased despite lower rates to the consumer, for while operating costs had increased, the depreciation and interest charges had decreased in still larger measure on account of better load factors, &c. The company's contracts for railway power supply in Chicago amounted now to 500,000,000 kilowatt-hours a year.

# THE CUNARD LINER AQUITANIA AND HER BOAT DECK

(*For description see page* 630)



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*** *With this week's number is issued, as a Supplement, a Two-page Coloured Drawing of the 7500-S.H.P. Turbine of the French Destroyer Renaudin. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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# THE ENGINEER.

*JUNE* 5, 1914.

### The Empress of Ireland.

THE facts of the loss of the Canadian Pacific Railway Company's steamer, the Empress of Ireland, soon after half-past one o'clock on the morning of Friday last, close to Father Point, in the mouth of the river St. Lawrence, have been before the public for nearly a week, and there is little cause to renew the melancholy story. The ill-fated vessel was struck nearly amidship by a large collier, and in little more than a quarter of an hour had sunk to the bottom, carrying with her over one thousand persons. She appears to have taken a heavy list almost immediately after the collision, with the result that boats would have been launched with difficulty even had there been time. As it was, but few were got into the water, and of the four hundred and fifty or so people saved many were picked up by the boats of the Storstad and many supported themselves on floating wreckage. It must be borne in mind that the vessel had only left Quebec the evening before, and that most of her passengers had had no opportunity of making themselves acquainted with her topography. Under the best conditions there must, then, of necessity, have been much confusion, and it is rather surprising that so many were saved than that so many, for nearly all were abed, were lost.

As to the cause of the calamity it is impossible to say anything at the present moment. The two captains, who have fortunately been saved, give stories which are diametrically opposite in essential points, and to attempt to attribute blame would be to prejudice a case which will be inquired into by the Canadian Government, with the assistance of Lord Mersey, in a few days' time. The most difficult statement to reconcile with the effects produced is that neither ship was moving at a high speed at the moment of impact. Captain Kendall, of the Empress of Ireland, says he was satisfied that his vessel had no way on her—we presume beyond that due to the current—and Captain Andersen, of the Storstad, has stated that his headway was nearly checked when the vessels came together. Under the circumstances it is extremely hard to believe that such extensive damage as would have led to the rapid filling of a great ship like the Empress could have occurred. Further examination of the evidence must be awaited with patience. The Empress lies in water so shallow that the tops of her funnels are visible at low tide, and it is probable that divers will have little trouble in making a full examination of her. Their report cannot fail to throw much light upon the disaster. We shall learn the extent of the damage, and be able to draw our own conclusions about the speed of impact. Captain Kendall has said that the ship was ripped from between the funnels to the propellers, but the statement, in view of the circumstances, cannot be taken too literally. To cause such damage would imply that the relative movement of the ships was higher than seems at all probable. We shall learn from the divers, too, if all the water-tight doors were properly closed, and if the bulkheads stood or were broken by the weight of water. In this case we are at the advantage that the sunken ship, unlike the Titanic, is so situated that we may learn from her whatever mournful lessons there are to be learned. One cannot help reflecting that here again, as in the Volturno, the principle of "boats for all" has signally failed. The Empress could have carried every soul on board in her boats, but she had no chance to use them. Had she rested on a fairly even keel there can be little doubt that the captain would have run her aground before many of the boats were floated. If any lesson in this respect may be gleaned from the accident, it is that self-launching rafts of some kind, something that will float off as the ship founders, are of more general value than boats which have to be lowered from davits. Of the construction of the ship much will be said. She was built by Fairfield's in 1906 on lines which were considered the best before the loss of the Titanic. She had an extensive double bottom, and was well divided, but she had no inner skin. Whether an inner skin would have saved her under the circumstances of the collision is a question which the evidence of the divers may help to answer. She appears to have been struck in the weakest place, full amidships, where the stiffening effect of the decks is reduced by the engine-room openings. But there seems to have been no question of cutting her in two. The effect, from meagre evidence we have, seems rather to indicate that the plates were ripped off by the bow of the Storstad as we rip the lid off a box with a screwdriver. If the divers can substantiate this view, a very strong case for the double skin will be presented, for it is probable that whilst many ribs would, of necessity, have been badly distorted, yet the inner hull might have held, at least for a time.

But when all is said, we have here a case against which it is hardly fair to ask the naval architect to provide. This was not a wholly fortuitous collision in a fog. The vessels had sighted each other at a sufficient distance apart to allow them to pass with safety. The extraordinary series of events which brought them to the same spot at the same instant of time must be deemed due either to faults in our navigation laws or in the observance of them, but the catastrophe could have been avoided had better means of communication between the vessels existed. If the Storstad had been fitted with wireless apparatus, the two ships could have kept in conversation with each other, in spite of the fog, and it is hardly conceivable that under such circumstances they would have collided. The Empress of Ireland was fitted with a submarine bell apparatus. Had the Storstad had one too the vessels could probably have learnt in time that they were on converging courses. On the whole, then, this is a case where our energies appear to be called upon rather to prevent the possibility of two vessels coming together rather than to the provision of means for preventing disaster if they should meet. We trust, then, that if invention is to be fired by it, as it was by the loss of the Titanic, it will take the direction of improved apparatus for advising vessels of the propinquity of each other under all climatic conditions.

### Compound Propellers.

THERE were two papers read before the Institution of Naval Architects last month which gave rise to a most interesting expression of expert opinion on what, for want of a better name, we might term the "topography" of the screw propeller. The papers were "Wake and Thrust Deduction," by Mr. W. J. Luke, and "Battleship Design," by Mr. T. G. Owens. Following naturally upon the subject matter of the first, and introduced as a side issue of the second, was quite a body of information, obtained both experimentally and from full-sized ships, bearing upon the propulsive efficiencies which may be reached with propellers in special positions relatively to one another. The discussion had little or nothing to do with the effect of dimensions or form of propeller *per se*, but dealt more directly with the virtue of special location and arrangement. It arose primarily out of the rather extraordinary results obtained by Mr. Luke when investigating the propulsive value of what he termed a "combination" propeller. This propeller is simply a combination of two ordinary screws, similar in all respects, except that one is a right-handed helix and the other a left-handed one; they have a common axis, and are placed one directly behind the other, turning in contrary directions, one by a solid shaft in the ordinary way and the other by a hollow shaft concentric with the first.

The term "combination" as applied to this propulsive agent was objected to by Sir Chas. A. Parsons as having been already appropriated to the well-known combination system of propulsion by reciprocating engines and exhaust turbines. It will serve our purpose equally well to call such propellers compound, and so perhaps avoid confusion of terms. These contrary turning compound propellers have much in their design that is attractive, for there can be little doubt that one of the sources of loss in propeller propulsion is the unavoidable dispersion of energy in other directions of flow of water than that in the direct line of advance, such, for instance, as that expended in giving a rotational motion to the wake. The compound propeller of contrary turning type seems to offer a perfect means, from a propeller point of view alone, of preventing this loss. As is well known, it is used very successfully on torpedoes, but there the end aimed at is to eliminate the steering effect of a single propeller. As this has been effected, we may assume that the wake stream-lines are straightened out as intended by the combined action of the two propellers, but at what expenditure of power is not known.

It is strange to learn that Mr. Luke found from repeated experiments that the actual screw efficiency in the open—that is to say, when unassociated with a ship model, was very low, while when tested behind a model the opposite was the case. With this result we must in the meantime be satisfied. It is the outcome of actual test, and not a pious opinion built on theory, and, to quote Mr. S. W. Barnaby on the point, "if we can place faith in the experimenter, the conclusion may be accepted." Mr. G. S. Baker quoted the experiments of Lieut.-Col. Rota with a similar propeller fitted to a 46ft. steam launch, which were said to show a gain of 20 per cent.—on a somewhat doubtful base of estimated mechanical efficiencies—and also spoke of the gain which has been reported from Germany as a result of fitting stationary blades immediately behind the propeller, these blades having a certain definite pitch calculated to make use of the rotational energy in the twisting wake of the propeller. These blades have the same purpose as the contrary turning propeller, and are more easily fitted; but, unfortunately, the mechanical difficulties, in the case at any rate of the contrary turning screw, put the project out of court as a practical proposition at present. Mr. Barnaby, in discussion, expressed the opinion that "nothing should cause us to adopt the complications necessarily involved in having to drive one shaft within another," and perhaps that is the view of most practical engineers. It was pointed out by Sir Archibald Denny that Mr. Luke's experiments had been made with models on which no shaft bossing had been fitted, and Sir Archibald said the effect of twist of water as it came off the bossing might affect the wake coefficients. This is quite true, and perhaps may explain the difference between the "open" results and those behind the model; but it does not quite explain why the results of the "open" experiment should be bad of themselves. Sir Archibald further mentioned the interesting fact that close proximity of a propeller to a very full-ended ship was very serious, and that in such a case the "efficiency might go all to pieces." He had proved that the propeller then acted like a centrifugal pump instead of a propeller, and it is evident that in such a case the water which is thrown off from the tips not only plays no part in propelling the vessel, but must be obtained from an indrawing of water at the centre, and if the obstruction of the full-ended ship prevents free access of the water from that direction. it will take the line of least resistance and come from aft, and the peculiar result he mentions will occur, that the vessel may even be propelled astern when the propeller is driven in the ahead direction. This is no doubt the extreme case, yet it is enlightening as explaining the kind of thing which happens when a bad efficiency is obtained behind a form of hull which does not give a free feed of water to the propellers. Another form of compound propeller mentioned is that in which two screws were fixed upon the same axis close together, as in the previous case, but not contrary turning, being both secured to the same shaft, and consequently turned together. The screws in this case were both of the same hand, but the after one had a greater pitch than the other, the idea being to pick up the moving water from the wake of the leading screw by means of the increased pitch of the follower. It will be seen that this design is a close blood relation of the propeller design so often advocated, which has a gradually increasing axial pitch, and no great advantage would therefore be expected. Sir Archibald Denny said that his firm had experienced a degree of success in tests carried out with such a propeller, but when applied to a full-sized ship the result was a complete failure. Yet a third type of compound propeller came up for discussion, which, while not unlike the previously mentioned one, differed from it in the fact that the forward propeller was some distance ahead of the after one, so that the two propellers, although fixed on the same shaft, might act on separate water, owing to the upward direction of the stream-line flow at the after end of the vessel. This form of compound propeller, which is sometimes called the "tandem" propeller, was adopted by Sir Chas. A. Parsons in the Turbinia when he was faced with excessive cavitation at high revolutions; it was also fitted to the side shafts of the first commercial turbine steamer, the King Edward, but subsequent experiments showed that one propeller was as good as two, and that the vessel did just as well with three propellers as she had done with five. Durand tried about thirty combinations of propeller in "tandem," but the best of them had 5 per cent. lower efficiency than an ordinary normal propeller.

All this information, coming from authoritative sources, is very interesting, and goes to confirm our often expressed opinion that the best result is obtained with an ordinary simple propeller designed to suit the condition to which it is to be applied, but this is, of course, not always easy to do. The value of such an interchange of opinion and information as has taken place in these discussions can hardly be over-estimated, and we sincerely hope that it is only the first of many "heart-to-heart" talks between experts, who have everything to gain from a pooling of their individual work in this way, to say nothing of the boon to the general body of the profession to which they belong.

### Trade Names.

THE increasing application of registered trade names to materials or products used in engineering work suggests some questions requiring careful consideration by those responsible for the preparation of specifications, requisitions for material, or any other documents which define their requirements or recommendations. Originally words used as trade marks were restricted by Legislature and the courts to such as were obviously meaningless and notoriously inappropriate to the quality of the goods, and their glaringly incongruous character afforded a safeguard against their unintentional or unconsidered use. This restriction has been removed by successive steps, from the decision of the House of Lords in the case of "Solio," which is neither meaningless nor inappropriate to a photographic printing paper, to the recent Trade Marks Act of 1905, under which trade names may be invented or inappropriate, but if invented they need not also be inappropriate.

These names are now frequently well-derived, euphonious, and suitable, and are therefore liable to become names in common use for the articles to which they have been attached. Notwithstanding any such common use, no maker or seller other than the registered proprietor can use them. An exception to this is suggested by the word "linoleum," which was originally a proprietary and exclusive word, but is now free. It had, however, become common during the continuance of the patent which protected the article it describes; but it is by no means clear that a word attached to a patented article will become free on the expiration of the patent. It certainly does not on the voidance of a patent under Sec. 27 of the Act of 1907. In a case under this section the original licensees of the void patent retain the trade name. The use in a specification of a registered name is equivalent to the prescription of a particular maker to the exclusion of others who may—except in the case of a patented article or process—make precisely the same article by the same method, and possibly as well or better than the registered proprietor, and is open to the objections which render the prescription of a particular supplier a course generally avoided. There are, of course, cases where these objections do not apply, as when a particular supplier has attained such a degree of eminence that it is desired to have—and pay for—his product and no other, and the prescription is often qualified by such an expression as "or other of equal (or approved) quality," which to some extent relieves it of objection. The makers of articles to which registered names are applied are not all of such pre-eminence as to justify their prescription on this ground. The articles may be the subject of patent rights or registration of design conferring on the proprietor a monopoly in their manufacture; but, if not, the proprietor's exclusive right is confined to the name, and anyone else is at liberty to make or supply the same thing, although he must not call it by that name. Nor is there any obligation on the part of the owner of the name not to vary the product to which it is attached. The name is a trade mark of purely personal significance. It guarantees the product as that of its owner, but it is no warranty of continued quality. By its use in a specification the engineer not only implies his requirement that what he has known by that name shall be supplied by its registered proprietor, but also his faith in the proprietor that he will not alter, in a manner unsuited to the intended purpose, the product he has called by that name, and over which he has an absolute control. He is also apparently subject to the contingency that the name may pass by assignment over which he has no control from a reputable to a disreputable proprietor. Moreover, should the engineer add "or other equal or approved . . ." he may be placed in a position of difficulty, because none but the proprietor can say without question what the name represents, and to determine in case of dispute what is equal or should be approved as equal, is a matter of considerable difficulty. Even chemical analysis, when applicable, is not a final solution, as the proprietor of a product of which the composition is ascertained may take shelter behind a suggestion that all depends upon the order of its mixing, or upon some evanescent ingredient, and either of these suggestions may be true.

It is scarcely possible, so long as proprietary articles made by secret process exist and have merits which justify their use, to avoid the use of trade names; but it is desirable that engineers should fully realise what they mean, and that they should never fall into the error of writing a trade name without a capital letter, and thus avoiding the reminder that it is of personal significance. This reminder is particularly necessary in the case of well-formed words which have come into common use and, once deprived of the distinguishing capital, may easily be used in ignorance or forgetfulness of their proprietary character, and without any intention to prescribe an exclusive source of supply. Hitherto the trouble with these words as affecting engineers has been principally confined to paints, cements, and the like. The use of trade names is now spreading to various descriptions of steel, in relation to which it is likely to be attended with more serious objection, on account of the greater importance of the material and the more serious consequences attending any uncertainty in its description or quality. It must be admitted that it would be unreasonable to make it a condition of the grant of the exclusive right to call a product by a certain name that the nature and composition of the product should, as in the case of a patented article, be made public. The right of the producer to the reputation he has made or the popularity he has obtained for his product must be admitted, and it cannot be said that the Legislature, in granting him the exclusive use of a suitable invented word, has acted hastily or without consideration. It must therefore be assumed that such words have come to stay, and that their use will extend to an even wider range of new materials. As it is difficult, and will become more difficult, for an engineer to avoid proprietary articles without depriving his clients of things which it may be to their advantage to have, he is faced with two alternatives: either to give such a description of the article required as will admit all competent suppliers of the desired article and will at the same time enable him or his inspectors to reject such supplies as are below the standard required, or frankly to admit the onus of personal prescription by using the trade name. In the latter case, unless the name is sufficiently characteristic clearly to indicate that it is proprietary, misconception may be avoided by adding the name of the proprietor.

### The Aeronautical Report.

THE fourth annual report of the Advisory Committee for Aeronautics, a summary of the contents of which appears in this issue, is a very satisfactory and creditable production. In two important respects it is a vast improvement on any of its three forerunners. In the first place, there is a gratifying absence of any indication that much time is being wasted at Teddington and elsewhere over the subject of dirigible balloons. Indeed, with the exception of some few tests on the strength of balloon fabrics and some investigations into the proofing of such material, the scope of the report is purely aviation. Secondly, the report as a whole reveals the fact that thoroughly practical people are mainly responsible for settling the nature of the research work to be undertaken. We notice repeatedly that such and such an investigation was undertaken at the request of the superintendent of the Royal Aircraft Factory. Mr. O'Gorman, if any, should know on what subjects information is most to be desired, and we trust that the policy of allowing those to suggest research work who are in every-day touch with the practical aspects of aviation will long be continued. Some critics of the Advisory Committee may be, and actually have been, inclined to find fault with the delay in publishing the report. It is more than eighteen months since the third report was published, and, moreover, none of the individual reports contained in the volume now before us is dated later than March, 1913. One of them is actually as ancient as December, 1911. It is certainly undesirable that valuable information such as that contained in the report should be held back unnecessarily. Still, the competition of the nations for aerial supremacy has grown very keen, and it is on the work of the Advisory Committee that this country depends very largely for its advancement. If, then, facts are discovered that tend to promote our aerial efficiency, it is only reasonable that we should expect them to be put to advantage quietly and not published to all the world until concealment is no longer necessary or possible. At the same time, it is desirable that the private builders of aeroplanes in this country should receive early intimation of fresh discoveries, and we may suggest that active co-operation between the Committee and the private builders would result in much advantage to both sides.

## LITERATURE.

*Practical Stone Quarrying.* By Allan Greenwell and J. Vincent Elsden. Pages 9in. by 5¾in., xx. and 564, also 339 illustrations. Crosby Lockwood and Son. Cloth, 12s. 6d. net.

IT is quite remarkable, taking into consideration the enormous importance of the industry, its widely extended character geographically and its venerable antiquity, that no books have come under our notice dealing with stone quarrying in general. Yet such undertakings produce an astonishingly large proportion of the mineral wealth contributed direct from natural sources to the enrichment of commerce from and in all parts of the world. There is another aspect of the subject that should lead to a demand for information about it. This is based on an impressive fact, perhaps not always quite obvious, that a quarry is an attractive feature to a wayfarer, and still more so, but from a different point of view, to those interested in the product, and although the two points of view may differ, those who take their standpoint from the latter, unintentionally perhaps, but nevertheless they do, assimilate some of the disinterested appreciation of the former. We have noticed this attractiveness of quarries in our holiday jaunts abroad as well as in our work-a-day trudges at home. We ourselves cannot resist when passing along the country peering out to see the progress of the disappearance of some landmark, and in some cases its replacement by an artificial mound; for example, Mountsorrel, in Leicestershire; Rowley Regis, near Dudley; the Clees, in Shropshire; and the delightfully situated quarries of Penmaenmawr, in Wales and Penlee, in Cornwall. The same changes are going on at many places abroad; entire mountains are disappearing from the Rhine Valley, and miles of the rocky banks on the upper Elbe are being levelled by the ruthless hand of the quarryman. While this volume has been about on our table, time after time visitors have turned over the leaves and have rejoiced at finding reference to quarries known to them, mostly recalling pleasant holiday associations, but frequently in connection with some big engineering work. This aspect of quarrying would, however, scarcely justify the arduous task of producing a book on the subject, but it shows that this industry has a veritable sentimental side in addition to its enormous economic significance, its widely extended prevalence, and its venerable antiquity.

It is about this subject that the authors provide us plentiful information, ranging from historical to the most modern, and drawn from sources at home and abroad. Judging from many quarries mentioned which we have visited ourselves, the information has a practical ring indicating it as being the product of personal inspections. The authors wisely at the outset state that they are restricting their attention to those rocks "not being of organic material, got for economic purposes other than the production of metals," whether these be won by open excavation or underground workings. Amongst the excluded rocks referred to as being of organic material the mineral fuels are numbered. Having defined the scope of their subject they proceed progressively. First to receive attention is the occurrence of the materials with the various conditions under which they are met with, the peculiarities they exhibit, and the origin of these. Valuable notes of warning are sounded at all stages, from the very inception of a quarrying enterprise, and so on through its development and exploitation, for it is pointed out many a promising undertaking has come to grief for want of observing precautionary measures. The modes of laying out quarries are next considered; then many methods of working them, with the implements and materials required and the ways of using them. Various ways of preparing the loosened material for the market come under notice, and modes of handling right from the quarry down to the ultimate shipping arrangements: cranes, cableways, gravity inclines, ropeways, and railways of all gauges. The matter is well illustrated, the illustrations being mostly well selected and depicting the points they are intended to elucidate; although it would be better if some more striking mode of reference could be used in the text.

It is a strange thing, however careful people are in classification, that it seems so easy for them to evade their own ruling. For example, the authors give a list of minerals excluding combustible materials—page 23—but including peats and lignites. They, too, have perpetrated another injustice to Ireland, for a map of Great Britain and Ireland is called a map of England and Wales. In dealing with the origin of characters in stone the woeful sufferings of the particle are explained and the name by which each particular discomfiture is known is given; Germans have furnished some fine examples, but some of our own professors can evidently hold their own in this direction; Professor Harker, for instance, has suggested for one form "*Fluidaltexturclivage*." It is interesting to note that the peculiarities of the general climatic conditions of North Wales are highly suitable for the purposes of the slate quarrying industry, and that this is a much more important factor than is generally recognised.

There are also chapters on accidents and their prevention, and on the laws and regulations relating to quarries; it remains to add that the authors are well-known authorities on matters relating to their subject, and that the book can be unhesitatingly recommended.

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*Switches and Switchgear.* By Professor R. Edler. Translated by P. H. Laubach. London: Constable and Co. Price 15s. net.

THE switchgear dealt with in this book does not correspond entirely with that used in this country, and, furthermore, the book is not quite up to date. But no other volume, so far as we are aware, covers the same ground; at any rate, no other volume written in the English language. It combines theoretical considerations with practical examples of design, and constitutes in a measure a history of the development of switchgear. Therefore the book fills a gap in this class of literature, and should, we think, prove useful and interesting to switchboard designers. It is a typical continental publication, which enters into much detail. Some of the chapters, as, for example, that on starting and regulating resistances, are highly theoretical, and call for a good deal of patience. The diagrams in some cases might be improved upon, particularly with reference to the size of the letters, which are very small and trying to the eyesight. Wiring diagrams in some parts of the book resemble those met with in patent specifications, and we should say that is where they have been taken from. The best way to indicate the field the book covers is to give the titles of its chapters, which are as follows:—(1) General remarks on the design of switchgear; (2) connecting links, cable sockets, connectors, copper bars, contact blocks, bolts; (3) contact springs and brushes, carbon contacts, devices to eliminate sparking at the main contacts; (4) switches and change-over switches for low-pressure and medium pressure; (5) high-pressure switches; (6) fuses; (7) self-acting switches (automatic switches), circuit breakers, time relays, &c.; (8) starting and regulating resistances, controllers; (9) accumulator switches, &c.

It is doubtful whether many switchboard designers have found time to enter into all the considerations Professor Edler enters into, but it must not be supposed that the book is only fit for professors and other mathematical geniuses. On the contrary, a great portion of it is written on practical lines, and may be understood by anyone possessing a fair electrical knowledge. The volume really appeals to several kinds of readers, but evidently it is intended mainly for switchgear designers. Central station men will probably find it a valuable help, for it indicates the classes of service different types of switches are fit for, and describes how starters, remote control switches, &c., are connected up. One of the most practical chapters is that on accumulator switches, which describes and illustrates many switches of this type. Some of these switches, however, are antiquated and seldom, if ever, met with in this country. Of course, in England large batteries are generally charged and discharged through boosters, and not through regulating switches. In certain quarters, however, as, for example, at Birmingham and Wednesbury, the latter have been used, and some engineers contend that regulating switches will eventually replace boosters at present at work in other parts, thus following the practice commonly adopted on the Continent. It remains to be seen, however, whether this change will be brought about. We ourselves are inclined to doubt it. But the matter has certainly been discussed on various occasions, and it seems to be a question which interests a good many engineers. In view of this, it is a pity that the author did not add a few descriptions and illustrations of these large battery switches actually in use on the Continent, for in this country very little information of this kind is available. The advantages these switches offer as compared with boosters might also have been set forth.

Another section of the book that should appeal to central station engineers and others in charge of electrical plants is Chapter VII. on automatic switchgear. Here the author describes various kinds of circuit breakers, reverse-current cut-outs, remote control switches, and automatic synchronisers. Practically all automatic synchronising equipments have been developed on the Continent, and are seldom referred to in English books. In the present volume, however, several of these equipments are fully described and illustrated, but the author expresses no opinion as to the advisability of using them. He points out, however, that, when the task of paralleling alternators is left to switchboard attendants, mistakes are liable to be made, and that serious results may follow. He further points out that a correctly designed automatic paralleling device would not allow of such dangerous occurrences, since a self-acting switch is entirely independent of the chance incidents that may influence human action and thought. The fact remains, however, that practically all alternators in this country are paralleled by switchboard attendants, and not by automatic switches, and it would be interesting to know to what extent those automatic paralleling devices are used on the Continent.

To sum up, the book contains a great deal of useful information, and is one of the best books on switchgear we have seen. No doubt the work of translating the original volume into the English language has been a long and tedious undertaking, and all praise is due to Mr. Laubach for the manner in which he has accomplished the task.

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*Indian Storage Reservoirs with Earthen Dams.* By William Lumisden Strange. Second edition. London: E. and F. N. Spon, Limited, 57, Haymarket, S.W. £1 1s. net.

ONE of the most conspicuous merits of this book, seen at a glance, is the admirable arrangement adopted by the author, whereby he makes his subject clear to the reader. The publisher has, moreover, ably seconded him by producing the work in type that it is a pleasure to read and by making the diagrams models of clearness.

The book claims to be a practical treatise on the design and construction of storage reservoirs with earthen dams, and it is what it claims to be. The subject is divided into four main heads, namely, the reservoir, the dam embankment, the waste weir, and the outlet. Under the head of the reservoir, are discussed the questions affecting the selection of the storage basin, such as a suitable site for the impounding dam, a configuration of the physical features upstream of the site favourable to the formation of a basin of suitable capacity, and a catchment area and rainfall yielding sufficient run-off to fill the reservoir. Then, in proper order, is considered what work the stored water will do, after allowing for losses in the reservoir and on its way to the crops which it is to irrigate, if it is this for which the reservoir is to be brought into being. Both in India and Egypt experience and observation have shown what quantity of water is required to bring irrigated crops to maturity, so that the determination of the amount of storage required for any given area is now a matter of simple arithmetic. As regards calculations of the yield of a catchment area made with figures representing the rainfall and the run-off, the author gives sound advice, stating that "such estimates are but approximations, and should be resorted to only in the absence of actual discharge observations." A very necessary caution, inasmuch as recorded observations have shown that the conditions of rainfall and catchment may vary to such an extent that the proportion of flow-off to total rainfall may correspondingly vary from nothing to 98 per cent.

The dam embankment, or the earthen embankment constituting a reservoir dam, is treated exhaustively as being the special subject of the book, in respect of which the author has the expert knowledge which comes of practical experience. A few paragraphs are devoted to a comparison between masonry, earthen and composite dams, and to a reference to certain American types. The different varieties of dam have each their own peculiar advantages and disadvantages, which are briefly stated. Earthen dams with core walls come under review. There are both practical and theoretical objections to the adoption of core walls, and the author points out that Indian engineers prefer to form earthen dams of well-compacted homogeneous material without any core wall. But the puddle trench below the base of the dam is, nevertheless, assigned its due importance, and therefore its purpose and principles of design and construction are considered at length.

The importance of the proper drainage of the base of the dam is also insisted upon, and the system of drains recommended is described. The preparation of the foundation bed of the dam by trenching, draining and benching, and the method of constructing the dam itself is then dealt with. The question of the safe limit of height for earthen dams is discussed. French engineers place it at 60ft., but the author points out that practice has sanctioned 80ft., and earthen dams actually exist of 100ft. in height and one of 125ft. But he gives utterance to a caution that, when 60ft. is exceeded, particular care is necessary in design and construction, and for dams exceeding 75ft. in height he recommends "drystone toes" to the slopes for the purpose of securing stability.

A chapter is then devoted to the consideration of the points affecting the design of the waste weir associated with the dam, and another chapter to the outlet and its valves and sluices—matters of importance in a reservoir project secondary only to that of the main dam.

There are twenty-six appendices of practical information, and, in addition, thirteen plates giving diagrams and details of actual designs, notably of the Maladevi tank project, which, however, has been abandoned since the first edition of the book under review appeared.

This book can be confidently recommended as a sound guide to all engineers who are called upon to design and construct earthen dams for storage reservoirs.

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## BOOKS RECEIVED.

*Modern Workshop Practice.* By Ernest Pull London: Crosby Lockwood and Son. Price 5s. net.

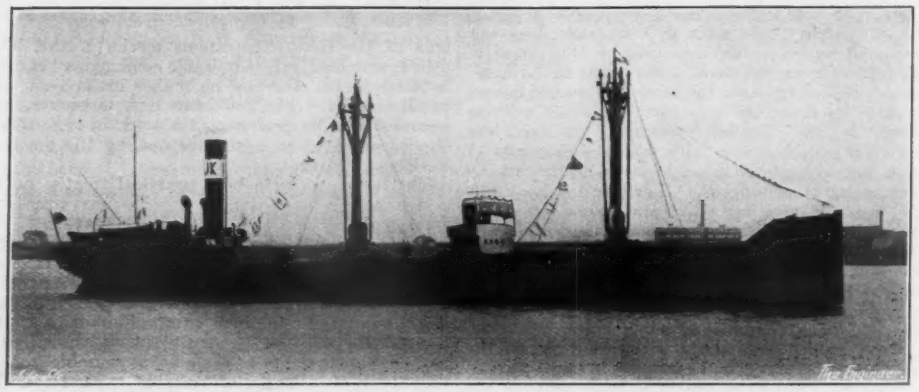
*Electric Wiremen's Work.* By J. H. Havelock. London: Crosby Lockwood and Son: Price 5s. net.

*Compressed Air.* By Theodore Simons. London: The Hill Publishing Company, Limited. Price 6s. 3d. net.

*La Cémentation de L'Acier.* By M. Albert Portevin. Paris (Ve): A. Hermann et Fils, 6, Rue de la Sorbonne. Price not stated.

# SELF-TRIMMING COLLIER DATETREE

ANTWERP ENGINEERING COMPANY, HOBOKEN, ANTWERP, BUILDERS

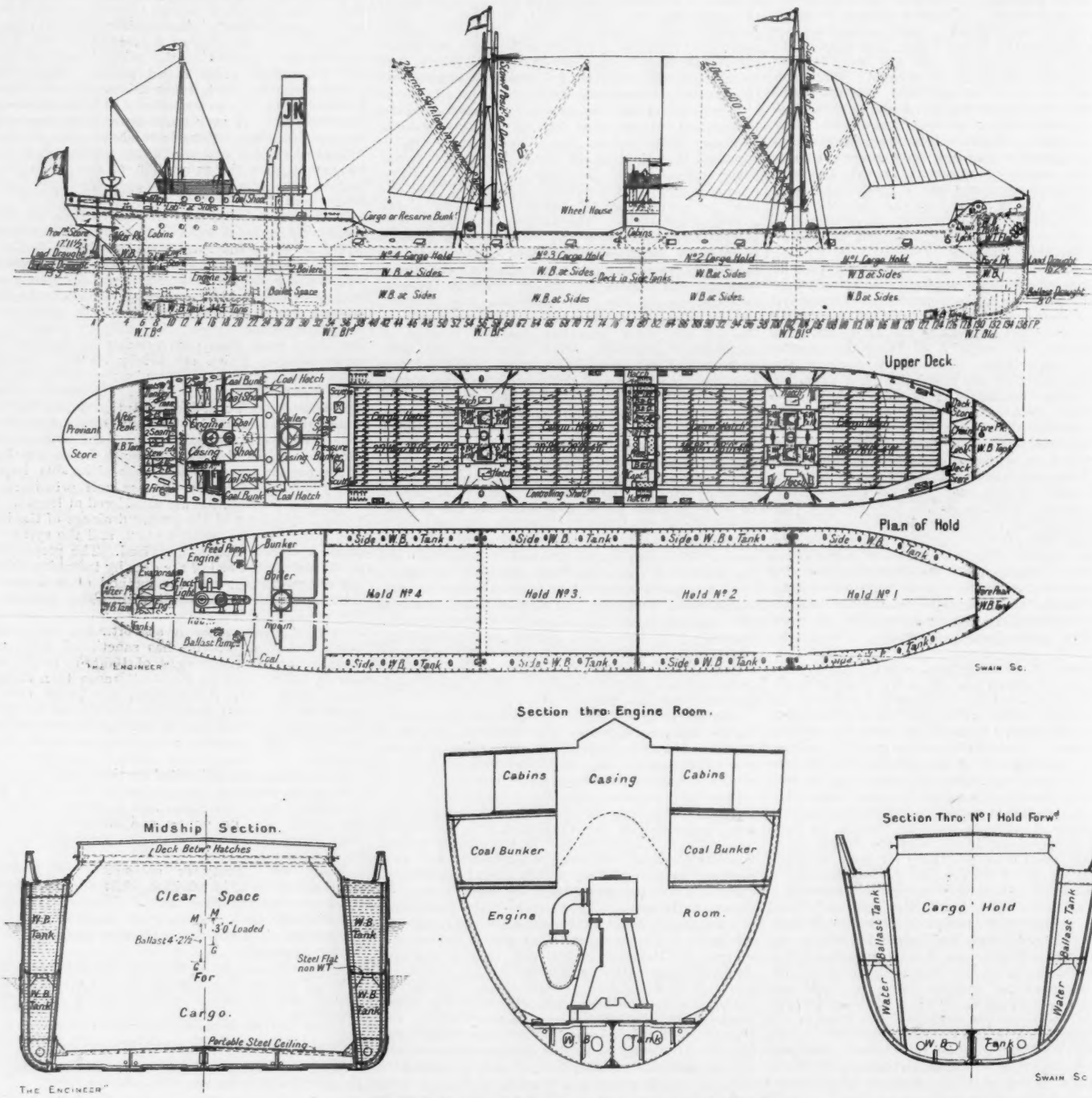


## A NEW TYPE OF SELF-TRIMMING COLLIER.

A NEW type of self-trimming collier has recently been constructed by the Antwerp Engineering Company, of Hoboken, near Antwerp, to the order of Messrs. Jones and King, the managing owners of the Tree Steamship Co., Ltd., of Cardiff. This vessel is constructed on a special patented system, and is the first of her class which has been built. She has a length between perpendiculars of 270ft., a breadth moulded of 40ft., a depth moulded of 20ft. 6in., and a deadweight capacity of 2700 tons on 17ft. 1in. mean loaded draught. Whilst designed primarily to serve as a collier and to conform to Admiralty requirements, she is intended to be used also as a deck cargo carrier, and is built with a specially broad beam proportionate to her draught, and with exceptionally fine ends in conjunction with the fullest possible midship section, all rise of floor and tumble home except above deck being dispensed with. The ballast tanks are not required to be filled for stability when the vessel is laden, and she therefore carries her cargo without the extra immersion due to them. There is ballast capacity of 1056½ tons, and it is placed at the highest maximum level, as will be seen from the midship section, so as to make the boat easy in ballast trim, and no double bottom ballast carried.

The engines are placed aft, so as to leave the best part of the ship available for cargo, and so as to avoid the use of a tunnel through either of the holds, which is troublesome when grab discharging. The net register—an important factor in vessels intended to be in and out of port frequently—is low—970 tons—considering the vessel's dimensions, erection, &c., as a deduction of 32 per cent. is made on the usual gross tonnage, the side tanks being deducted for the net register. The wings, which generally go into the tonnage of the ordinary type of collier without representing earning capacity, are not employed. The sheer is dispensed with so as to prevent the vessel trimming by the head when loaded, owing to the excess of cargo carried forward, as is the case with a sheered vessel having engines aft. The usual protection has been obtained by sheering the bulwarks and also providing a bulwark round the poop and forecastle instead of the usual open rail. As the vessel has no sheer the midship freeboard is considerably more than usual; that is to say, for the same draught the ship is deeper amidships, this design giving better proportion of length to depth in case of a very shallow draught being required.

The side tanks have an advantage over the double bottom in the fact that they maintain their capacity right up to the forepeak bulkhead instead of tapering off, so that the vessel does not trim too much by the stern in ballast, as frequently happens. As far as floatability goes, in case of accident the vessel is claimed to be superior to the usual boat of her size, as the holds are divided up by extra steel bulkheads so as to allow of filling any one compartment in the vessel without sinking her. Moreover, the side tanks are specially subdivided into four tanks on each side. The floors are not pierced with manholes, and double reverse frames are fitted throughout the holds.




ELEVATION, PLANS, AND SECTIONS OF THE COLLIER "DATETREE"

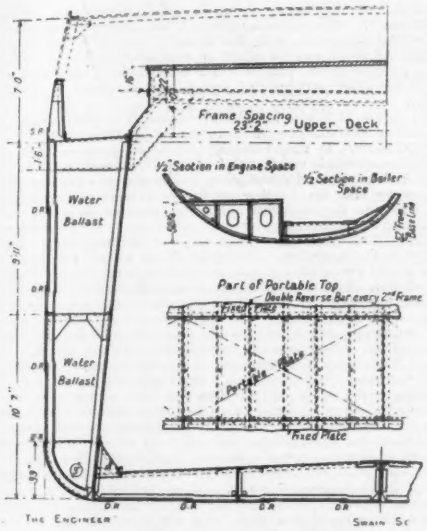
There is no necessity to utilise shifting boards, as the cargo cannot move into the wings.

The vessel has been made to embody as much repetition work as possible, all shell plates, stringer plates, &c., being of standard length, breadth, and riveting as far as

possible so as to suit the builders' template system, which aims at avoiding excessive handling, the whole work being prepared on the ground before hand and sent direct to the ship. The amount of machine riveting is much in excess of the usual. A non-water-tight flat exists for the whole length of the side tanks, but, contrary to usual practice, this offers no obstruction in the hold. The hatch sides are incorporated with the longitudinal bulkhead, making the ship much stronger longitudinally, and the extra transverse bulkheads satisfactorily resist racking strains. The ballast tanks are accessible at all times, even when cargo is in, and they have a full walking height. Repairs are conveniently effected, as the floors can be got out from the inside without having to take off the shell plating. The bunkers are completely self-trimming, and they discharge automatically on to stokehold plates.

The draining of the water ballast tanks, which takes up much time with a flat double bottom if the last 15 or 20 tons is wanted out, is not so serious a matter in the Datetree. The ballast tanks empty themselves automatically down to the light line. A pair of ballast donkeys are fitted for emptying the remainder as quickly as possible. No capacity is lost owing to frames, beams, &c., as these do not exist in the hold, nor are there any pillars in the holds. Sweating is prevented by the protection given by the side tanks and the fact that the whole of the hold is covered by the wood hatch covers. This type of vessel is claimed to be eminently suitable for the American Lakes trade, as the facilities for rapid loading and discharging are better than usual.

The actual trim of the vessel when in ballast without permanent bunkers is 13ft. aft and 8ft. forward, the propeller being fully immersed when the bunkers are in, whilst the actual trim when fully loaded with half of her bunkers out is 3ft. by the stern, but by filling up the forehold she is brought to practically even keel in this condition when required. The vessel is specially suitable for




CROSS SECTION OF COLLIER DATETREE

grab discharging on account of her flush floor, and she has eight cargo winches with 7in. by 10in. cylinders, two per hatch, each pair being coupled athwartships for heavy lifts. There are eight Mannesmann tube derricks to lift 6 tons each, these being 50ft. long and so placed as to discharge much higher than usual, and they are fitted on tables with outriggers. There are no ladders fitted in the hatches, but some are placed on the bulkheads with special scuttles for access. The reserve bunker discharges into pocket bunkers or the main hold as may be desired. A steam ash hoist with an overboard shoot is fitted. The steering gear acts directly on the quadrant without any blocks. The crew is berthed aft in separate rooms with mess-rooms and wash-place and steam heating.

The machinery, manufactured by Messrs. McColl and Pollock, of Sunderland, consists of triple-expansion engines with cylinders 20in., 33in., and 54in., with a 36in. stroke, and two single-ended boilers 14ft. diameter by 10ft. 6in., 180 lb. pressure, stoking from aft. The fully loaded speed of the Datetree is 10½ knots and the ballast speed 11¾ knots, the indicated horse-power being 1266. Her daily consumption of best Welsh coal is given as being about 15¼ tons, and in her ordinary working bunkers she can carry 113.5 tons, while there is a reserve of 100 tons in her poop 'tween deck bunker.

## SOME OF THE COALFIELDS OF WESTERN CANADA.

*(From a Correspondent.)*

GOING west from Winnipeg the traveller is carried over hundreds of miles of prairie, which, during the autumn, is more or less covered with wheat. Underlying these vast areas there are in many places enormous deposits of lignite coal, which do not come into view until about Medicine Hat, where, in addition to coal, the town's greatest asset is its gas wells, and to Calgary, further west, the same remark may apply. Going still further west from Medicine Hat along the Crow's Nest Pass Railway we find the district between Taber and Lethbridge dotted over with collieries. At Lethbridge, in particular, we pass the noted Gault collieries. All the collieries find a good demand for their coal output during the spring, autumn, and winter, but during the summer some of them are closed down altogether. After passing over a considerable mileage where agriculture reigns predominant, we approach the foothills of the Rocky Mountains, and find the lignite coals giving place to bituminous coals, such as those worked at the Bellevue mines. One of these mines is notorious as having been the scene of three disasters, in one of which thirty-one lives were lost. A little further west we pass over the enormous rock slide at Frank, which, only about ten years ago, wiped out the whole of the outside works of one of the collieries and also part of the town, causing a large loss of life. The top of Turtle Mountain, from which the slide originated, is even now considered so insecure that part of the town has been compulsorily moved and some of the colliery workings at its base abandoned. Two of the collieries in this district have made some coke, but at the present time no coke ovens appear to be in use.

Passing through the "Gap" we come into the Blairmore–Coleman coalfield, where Coleman coke ovens are seen in active operation close to the railway line. This district for miles to the south and north is underlain with thick and valuable seams of coal, which, for want of railway transportation, will have to remain undisturbed until the demand has materially increased. A vast area of coal land has, however, been staked and is paying taxes to the Government. In many cases the owner of the coal rights also owns both the ground surface and the growing timber. To maintain possession of these claims a certain value of development work must be done yearly by the holders. This charge often becomes very onerous before one pound of coal has been sold. Many of these coal claims are held by speculators who have not, and never had, any intention to work and develop them into collieries, but solely to hold them as a speculation for a cash sale. This too often leads up to another difficulty, viz., that the major part of the subscribed capital is paid over to the speculator and insufficient funds are left properly to develop the coal seams.

A range of the basal limestone, as at Frank, is again passed through west of Coleman, after which we come into what is known as the Crows Nest Pass and Elk Valley coalfield. This field has an abnormally massive deposit of coal at Corbin, some miles south of the main railway line. One part of this deposit, at a height of 6000ft. above sea level, is being mined with a steam shovel. On the north side of the line the Elk River coalfield extends right up to the divide between the Elk and Kananaskis Valleys. It is at present unworked commercially on account of there being no railway transportation, although practically the whole coalfield is held by strong companies. Probably all the seams of coal are bituminous and will make coke.

At Michel, on both sides of the railway and southwards to and below Fernie, the most extensive developments of any in this coalfield have been made, the output of the two companies, viz., the Crows Nest Pass Coal Company, Limited, and the Hosmer Mines, Limited, being equal to a million and a-half tons per annum. More than a thousand tons per day of coke are shipped to the smelters, the whole quantity being made in beehive ovens, with a consequent entire waste of its most valuable by-products. The principal mining centre of this area, known as Coal Creek, is five miles east of Fernie and cannot be seen from the main line.

The southern part, known as Carbonado or Morrissey, is at present unworked. The mines have, however, been opened up, and are now closed down in consequence of the dangerous conditions resulting from the enormous outbursts of gas and dust which have occurred there. These outbursts have in no case caused an explosion, but have asphyxiated the men before they could escape out of the mine. These outbursts of gas were in every instance accompanied by tremendous volumes of the finest dust, and in one case the quantity was estimated to have been fully 5000 tons. Another peculiarity of this portion of the field is that the seams of coal are of non-coking quality. From this point to the Pacific Coast only one coalfield of similarly good coking quality has so far been discovered, viz., at Coalmont, in the Similkameen Valley.

Returning to the main Atlantic to Pacific Railway line west of Calgary we come across the first important coal development at Mitford (Cochrane), where English capital is engaged in developing a large area of semi-bituminous coal. No other important opening is in evidence for many miles, but from Morley and on to Canmore, Anthracite, and Bankhead the traveller has part of the Cascade steam coal and anthracitic coalfield in view, and away down the valley of the Kananaskis River to the south lies the remaining part of this very rich coalfield. The principal developments have been at Canmore, Anthracite, and Bankhead, and at the present time the Cascade field is receiving more attention from capitalists. Two companies, viz., the Canmore Navigation Coal Company, Limited, and the Cascade Coal Syndicate, Limited, controlled by British capital, are engaged in active development operations. Practically all the way from the Canadian Pacific Railway main line to the head waters of the Kananaskis Valley there are enormous basins of coal, the seams of which are in many cases very thick. Many of the seams have a low ash content and are mostly of a semi-anthracitic quality or equal to No. 2 Rhondda steam coal. Better to exemplify the prodigality of the coal deposits of this region a section of part of one basin is appended to these notes.

At Bankhead the semi-anthracitic small coal is converted into briquettes, which are extensively used for locomotive and house-fire purposes. The greatest drawback to this industry is the want of a cheaper binder than pitch, which is now being used and is brought from Duluth or elsewhere in the United States, thus entailing a long haul and a consequently very heavy freight rate. This pitch might be produced from the coke ovens in the Crows Nest Pass district.

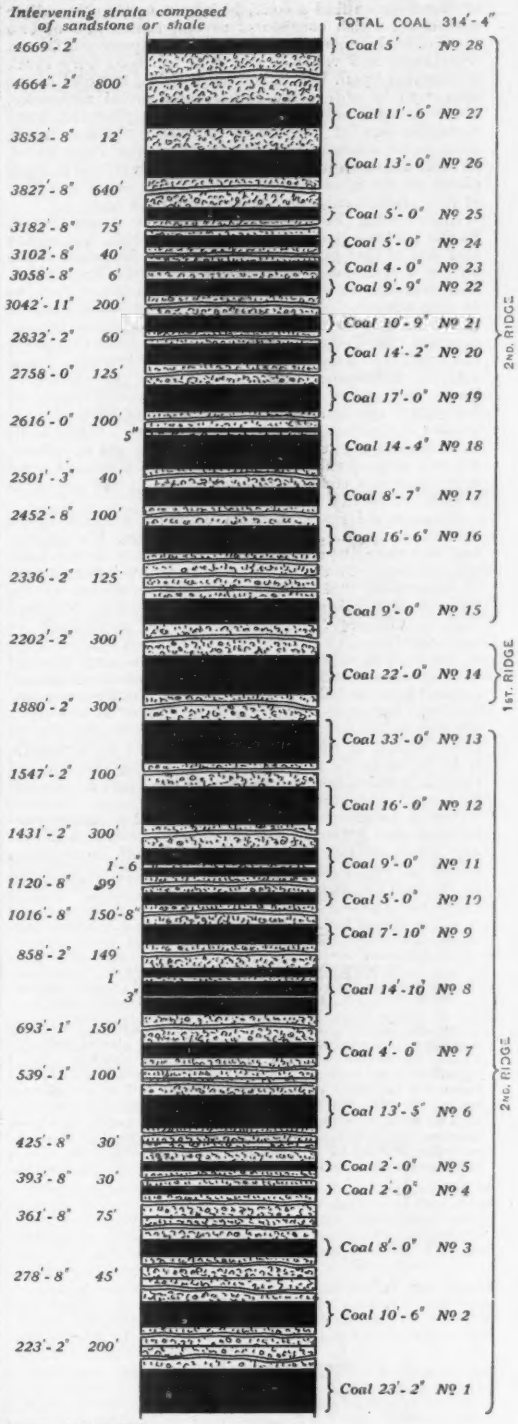
After leaving Banff no coalfield is again seen until reaching Sicamous Junction, where to the south there are bituminous seams of coal at Enderby and on the west side of the Okanagen Lake. Passing on to Kamloops coal seams are found in the immediate neighbourhood, and there is also to the north, about 60 miles up the North Thompson River, a bituminous coalfield at present unworked. The line of the Canadian Northern Railway passes through this property.

No signs of coal are again seen between Kamloops and Vancouver, but 40 miles to the south-east of Spences Bridge is the Nicola Valley coalfield, which yields bituminous coal, some of which is of coking quality. The major part of the output of this field is used by the Canadian Pacific Railway, although it is the nearest inland coalfield to Vancouver, B.C. South-east of Nicola is the Quilchenna coalfield, and due south again the Princeton lignite coalfield.

To the north-west of the latter is the Coalmont coal basin in the Tullameen Valley, where probably the best coking coal west of the Crows Nest Pass is being developed. The Great Northern Railway Company has run its line into this field as far as Tullameen. Some coal is being shipped from both the Nicola and Princeton coalfields into Vancouver.

Only a small percentage of the coal used in Vancouver is supplied by the inland collieries, on account of the prohibitive freight rates, and therefore the major part of the supply is procured from the Vancouver Island and Washington collieries. All this coal is shipped in by scows, and bunker coal by hulks. During the strike of miners on Vancouver Island several cargoes of coal were shipped in from both New South Wales and Japan.

The Vancouver Island coalfields cover a very considerable area, and may be described in general terms as commencing near the north end of the island and extending down the whole of the east coast. On the west coast are the Quatsino and Carmanah coalfields, on which no develop-




SECTION THROUGH CASCADE COALFIELD

ment is in progress. A little development is being done on the Central or Alberni field. The Suquash, now being developed, may be considered as being the same as Quatsino. The Comox or Cumberland, the Nanaimo, the Cranberry–Cedar, and the Extension coalfields are all being actively developed. None of these fields of coal contains more than three workable seams of coal. The coals are largely used for bunkering steamers, and all the collieries are mainly dependent on sales to places on the Pacific Coast. The main shipping points at the present time are Union Bay, Nanaimo, Boat Harbour, and Ladysmith. The extent and possibilities of the coalfields of Vancouver Island are not well defined, but there cannot be a doubt that they are capable of much more extensive development.

On Graham Island there are very extensive deposits of coal, varying in quality from lignite at the north end of the island to anthracite at the south end, but at the present

moment there is not one single operating colliery, although the whole possible coalfield has been staked. Only a few tons of anthracite coal has been shipped from Cowgitz, on the Skiddigate Inlet, and the real value of this coalfield has yet to be proved. Crossing over from this island to the mainland brings the visitor to Prince Rupert. This port will presently become very important as a shipping point, seeing that it is the western terminus of the Grand Trunk Pacific Railway system. No coal is met with near the coast nor until about 14 miles east of Hazelton in the Bulkley River Valley, where the seams are bituminous and of coking possibilities. This field extends some distance to the south-east, and is also found on the Copper River. At one time the Grand Trunk Pacific Railway Company proposed to construct its main line up the Copper River from the point where it joins the Skeena, and to come out at Telkwa or thereabouts, in which case it would have passed directly through this coalfield. The best access to the Copper River coalfield now appears to be from Telkwa.

Passing up the Skeena River for about 140 miles north of Hazelton we find a coalfield known as the Groundhog anthracite, which consists of several basins and of two series of coal seams distinguished as the Upper and Lower. The extent and value of this field has been very much commented upon, but, taken as a whole, the coal seams appear to be anthracitic rather than actual anthracite, and are, until railway transportation is provided, commercially out of the Coast markets. Further north bituminous seams of coal are found on the Tuya River, 30 miles above its junction with Stikine River, and in other places of the same district. One of the seams has 30ft. of very clean, hard, non-coking bituminous coal.

Approaching Fort George along the Grand Trunk Pacific Railway lignite coal is again met with, and on the east side of that place, and only a few miles south of the line, is a bituminous coalfield known as the Bear River. This field also awaits development, which is not likely to be long delayed. Still going eastwards towards Edmonton and east of Tete Jaune Cache coalfields again become plentiful, the Yellowhead Pass Coal and Coke Company, Limited, the Jaspar Park Collieries, Limited, being actively developing; also Broule Lake, the Mountain Park, and others on the Brazeau branch. Nearer to Edmonton the lignite coals are again met with and are worked at Gainford and many other places. There is one notable sinking in the neighbourhood, viz., the St. Albert, where a large circular shaft has been put down and cased with reinforced concrete through the sand and gravel for a depth of 205ft.

There is a large number of collieries working lignite coal in every direction around Edmonton, Wetaskiwin, and Red Deer, the coal in several cases being of very high-class quality. To the west of Red Deer development work in bituminous coals is being actively carried out by the German Development Company, the Canadian Northern Railway Company, and others. Further south again we have the Cascade coalfield, already referred to, and again on the foothills side of the Rocky Mountains huge deposits of coal of a bituminous and semi-anthracite character on the Elbow and Sheep Creek Rivers. Many other workable coal basins lie within the area referred to, but those already named are sufficient to exemplify what an enormous wealth of coal ranging from lignite to anthracite is to be found in this western part of the Dominion of Canada, without taking into account the Peace River coalfields and those still further north.

The metalliferous wealth is equally bountifully distributed throughout British Columbia, and as fast as railway transportation is provided so fast will the immense wealth of this western province become more apparent to the world at large.

## WIRELESS TELEGRAPHY.*

### SPARK SYSTEMS.

*Damped Electric Waves.*—After some preliminary remarks regarding the production and formation of electro-magnetic waves, the author went on to say that the simplest way of signalling is by means of damped electro-magnetic waves, and these can be easily produced by a spark coil or transformer having its two high-tension terminals connected respectively with an aerial wire and with the earth, a spark gap being placed between the connections in the manner illustrated diagrammatically in Fig. 1. The current through the primary circuit of the coil is controlled by the key K, so that by holding down the

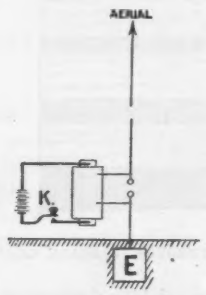



Fig. 1—PLAIN AERIAL

key for long or short periods, long and short series of waves can be transmitted corresponding to letters which are represented by the dots and dashes of the Morse code. The high-tension current charges the aerial wire until the charge increases to such an extent that it sparks across the gap, and the aerial discharges itself to earth, the strain being broken down and a wave given off. The aerial, however, not only discharges itself, but, as it were, over-discharges itself. The current rushes back again over the spark gap and charges the aerial. This oscillatory flow backwards and forwards between the aerial and the earth occurs a number of times until the energy is dissipated partly by radiation and partly by resistance and other losses, and insufficient remains to maintain the spark across the gap. The coil then charges the aerial again and the same action is repeated.

The charge which can be given to an aerial wire is limited by the capacity of the wire, which is usually very small. Moreover, the aerial wire in Fig. 1 not only forms the charging circuit, but the radiating circuit, and the arrangement results in the production of highly damped oscillations, which soon die away. A good oscillatory circuit should be a bad radiating circuit, so that the charge will continue to oscillate for some considerable time before being wholly dissipated. To meet this requirement the oscillatory circuit is constructed by the Marconi Company of London and by the Telefunken Company of Berlin, as a separate circuit and is coupled to the radiating circuit wherein slightly damped oscillations are produced, and which, when impinging on a distant receiver, create a cumulative effect that is very desirable.

*The Marconi System.*—Fig. 2 shows diagrammatically a popular

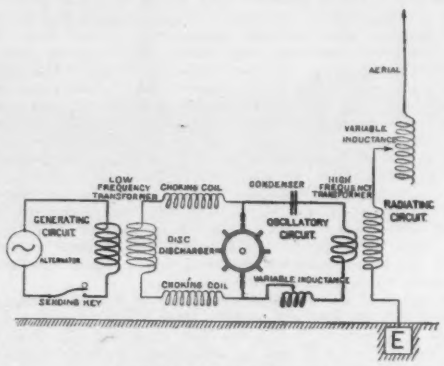



Fig. 2—MARCONI SYSTEM

arrangement of the Marconi system. The electric current is generated by an alternator and passed through the primary coil of a low-frequency, iron core transformer by which its voltage is increased to that required for charging the condenser in the oscillatory circuit. "The low-frequency or alternating circuit includes additional inductance either in the transformer primary or secondary circuit adjusted so that the natural period of the alternator-transformer-condenser circuit corresponds with the alternator frequency, this adjustment is provided so that the condenser charging current may be about zero value when the condenser is about to discharge." The oscillatory circuit comprises a condenser, the primary coil of a high-frequency air core transformer, a variable inductance for altering the wave length, and a disc discharger by which the condenser is discharged. This discharger consists of a revolving toothed wheel placed between two stationary teeth, so that every time a pair of teeth comes opposite the stationary teeth the current sparks across and the condenser is discharged. The time of charge corresponds to a half cycle of the alternator, and to the period elapsing during which there are no moving teeth opposite the two stationary teeth, the voltage or pressure to which the condenser can be charged depending on the amount of energy which can be stored in the condenser during the time of charge.

The radiating circuit in Fig. 2 includes the secondary coil of the high-frequency transformer by which energy is absorbed from the oscillatory circuit and radiated from the aerial wire in the form of electro-magnetic waves. A variable inductance is included in the radiating circuit for the purpose of varying the wave length so that it may be brought into tune with the oscillatory circuit. Suppose it is desired to send a signal. The sending key is pressed down, and thus allows the current from the alternator to flow through the primary coil of the low-frequency transformer which induces a high-voltage current in the secondary coil. This high-pressure current passes round the circuit and charges the condenser, which is periodically discharged, say, 450 times per second, by the revolving toothed wheel. Each condenser discharge produces a group of electric oscillations in a manner similar to that described with reference to the discharge across the spark gap in Fig. 1. These oscillations, by passing through the high-frequency transformer, induce oscillations in the radiating circuit which alternately charge the aerial wire in opposite directions, and in so doing produce electro-magnetic waves which are propagated outwards in all directions over the surface of the earth. It will be noted that choking coils are placed between the low-frequency transformer and the oscillatory circuit. These are inserted for the purpose of preventing the high-frequency oscillations from passing into the low-frequency transformer and doing possible damage.

*Telefunken System.*—This system is illustrated diagrammatically in Fig. 3, from which it will be seen that it is similar

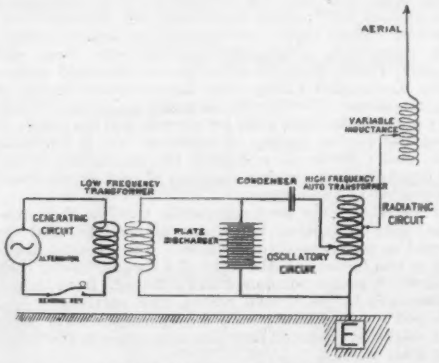



Fig. 3—TELEFUNKEN SYSTEM

to the Marconi system; the two companies, however, agreed upon terms which avoided litigation. The principal differences between the two systems are the method of discharging the condenser and the method of exciting or producing oscillations in the radiating circuit. The discharger, which is illustrated diagrammatically in section in Fig. 4, consists of circular plates of copper separated from each other by mica distance-pieces of about 2 mm. in thickness. The spark forms at any point on the flat surface of the plates: it is then forced towards the periphery in a radial direction by the electro-magnetic field, and is eventually extinguished on its path by a circular groove which the spark cannot bridge. Between each pair of plates is a large disc of thin copper, which is effective in radiating the heat generated by the spark. Short-circuiting plugs, which can be inserted between the copper discs, are provided in order to short-circuit as many gaps as may not be required. The quenched spark discharge may thus be adjusted to suit the voltage, and consequently permit of variations in the power utilised. For example, if small power is required a number of gaps will be short-circuited, and the alternator voltage reduced—if full power is required all the gaps will be opened and the alternator voltage raised to correspond with the number of gaps. It will thus be seen that by connecting a suitable number of gaps in series and adjusting the voltage, it is possible to keep the energy per gap from exceeding a certain value, and thus avoid overheating, which would prevent the quenching of the spark. Since the energy transmitted varies as the square of the number of spark gaps, the regulation by short-circuiting covers a wide range. Thus, if there are 10 gaps and 9 are cut out, the maximum energy can be reduced to 1 per cent. The pressure per gap is approximately 1200 volts, so that if 10 gaps are in use the charge given to the condenser will reach a pressure of approximately 12,000 volts before discharging across the gap

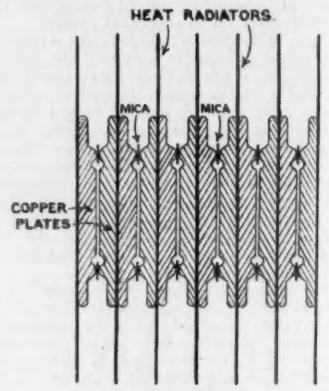



Fig. 4—DISCHARGER

and round the oscillating circuit in which it oscillates. It will be noticed that the radiating circuit is not indirectly coupled to the oscillatory circuit, as in the Marconi system, but is directly coupled by what may be called an auto-transformer, consisting of a copper helix, one part of which is included in the oscillatory circuit, the other part forming a portion of the aerial or radiating circuit.

The action of a coupled circuit transmitter, whether on the Marconi or Telefunken system, is less simple than would appear at first sight. It might seem natural to suppose that the oscillatory circuit is unaffected by the radiating circuit, but this would be an incorrect assumption, because, just as the currents flowing to and fro in the oscillatory circuit induce similar oscillations in the radiating circuit, so do the induced currents oscillating in the radiating circuit tend to react on the oscillatory circuit. Thus when the oscillatory circuit has given up its energy to the radiating circuit, the latter circuit rebounds, as it were, and starts giving back some of its energy to the oscillatory circuit. One circuit reacts on the other till the oscillations induced alternatively in each circuit die away or are drowned by the violent oscillations which are being frequently produced with maximum amplitude by the condenser discharges. This action of the energy swaying backwards and forwards from one circuit to the other is illustrated graphically by Fig. 5. The upper curve represents the oscillatory circuit and the lower curve the radiating circuit. It will be seen that the oscillatory circuit commences with a maximum amplitude which corresponds with the moment of discharge of the condenser, and that the oscillations are absorbed by the radiating circuit, in which the induced oscillations are of maximum amplitude when the whole of the energy has been absorbed by it from the oscillatory circuit. The radiating circuit then reacts on the oscillatory circuit, with the result that instead of the whole of the energy remaining in the radiating circuit and being dissipated in the form of electro-magnetic waves, it is partly wasted in uselessly exciting the oscillatory circuit. This exchange of energy continues until the whole of the energy is dissipated or radiated from the aerial wire. The entire effect extends over only a fraction of a second, and is equivalent to the time during which each spark occurs at the discharger.

If a Marconi revolving disc discharger is suitably designed and run at a predetermined speed, the period during which two moving teeth are passing the two stationary teeth, is equal to the period during which the whole of the energy is originally transferred to the radiating circuit; and as the spark is then extinguished, the teeth having moved on, it is impossible for the energy in the radiating circuit to flow back into the oscillatory circuit. The result is that the oscillations continue in the radiating circuit with a steadily decreasing amplitude. During this time the condenser is again being charged ready for dis-

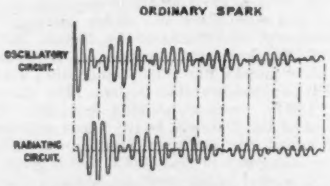



Fig. 5—SWAY BETWEEN OSCILLATING AND RADIATING CIRCUITS

charge by the next two moving teeth, which pass the two stationary teeth, when a new series of oscillations will be induced in the radiating circuit. This true effect is obtained with discs running with high peripheral speed, and working with long waves and loose coupling, as the disc may then be arranged to cut off a discharge or spark before any material part of the energy communicated to the aerial is returned to the oscillatory circuit.

*Undamped or Continuous Oscillations.*—An undamped or continuous oscillation is one which oscillates continuously with the same amplitude. At present there are two notable systems which produce undamped or continuous waves: they are the Goldschmidt and Poulsen.

*Goldschmidt System.*—In theory this system approaches very closely to the ideal; but so far it has been unfeasible to carry out in practice what appears so desirable in theory. Theoretically the system consists of an alternator which produces an alternating current having a very high frequency; the frequency corresponding to the frequency of the oscillations that it is desired to produce in the aerial wire. To understand why such a system is impracticable for commercial use, that is, for from ship to shore signalling, it will be necessary to consider the construction of an alternator. It should first be stated, however, that, according to international law, the wave length used on ship stations must measure either 300 m. or 600 m., the ability to radiate a 300 m. wave being compulsory, but the use of a 600 m. wave is optional. Therefore, in order to be suitable for use on shipboard the alternator must be able to produce oscillations which will give a 300 m. wave.

Now, it was shown earlier in the paper that a 300 m. wave corresponds to one million oscillations per second, and therefore

* Abstract of paper read before the North-East Coast Institution of Engineers and Shipbuilders by H. Fothergill, April 23rd, 1914.

the frequency of the alternations in the current produced by the alternator must equal one million per second. Usually the frequency of an alternator depends on the revolutions per minute and the number of magnetic poles. Even supposing the periphery of its moving part were divided into 100 poles, which is a large number, the speed would need to be 1,200,000 revolutions per minute in order to obtain a frequency of 1,000,000 per second. This speed is, of course, obviously impossible. However, according to a special arrangement of Goldschmidt's, the magnetic field of his alternator is rotating, not mechanically, but electrically, while at the same time the armature is rotated mechanically in the field in the opposite direction. The result of this is the production of a frequency depending on the sum of the rates of rotation of the magnetic field and of the armature; and current at this higher frequency is carried back to the field and produces a more rapidly rotating field than the first. To this, again, is added the frequency produced by the rotation of the armature. This process is repeated several times until the required high frequency is reached. In theory it is feasible, but in practice the complications and loss of energy at each step are so great that the inventor has not yet exceeded a frequency of 40,000 per second, which is a long way short if 1,000,000; the frequency required for the 300 m. wave. The system is therefore unsuitable for short wave lengths, and is not likely to come into use for from ship to shore signalling.

Let us consider, then, whether or not it is possible to use such

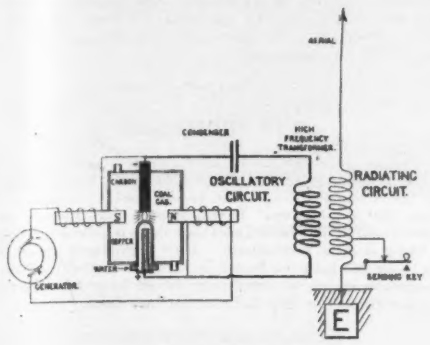



Fig. 6—POULSEN SYSTEM

an apparatus for long wave lengths, such as are used in high-power long-distance stations. The wave length corresponding to a frequency of 40,000 per second would be 7500 m. in length, a wave length which has been frequently used, and therefore the system could be employed for long-distance signalling, but apparently from the negotiations between the Postmaster-General and the Goldschmidt Company in Germany, the system has not yet proved itself reliable. From the information available it seems as if Goldschmidt proposes to use for Transatlantic signalling a 500 horse-power steam engine driving two dynamos of nearly 200 horse-power each, the armatures of these machines being connected to a motor that drives the high-frequency alternator, the rotating part of which has no fewer than 384 poles. It would seem that the general plan adopted in damped wave systems of driving the whole of the moving plant direct on one shaft from a steam turbine is more simple and desirable.

*Poulsen System.*—Nearly fourteen years ago it was shown by Mr. W. Dudell, the past-president of the Institution of Electrical Engineers, that when an electric arc between two solid carbon rods, as in a street arc lamp, is shunted with a condenser and inductance in series, electric oscillations are set up in the condenser circuit. In 1903 Valdemar Poulsen, of Copenhagen, described important improvements in this method of creating electric oscillations. He produced an electric arc between a carbon rod and a copper rod which was kept cool by water circulating within it—see Fig. 6. The arc was at the same time surrounded by an atmosphere of hydrogen or a hydrocarbon gas or vapour and crossed transversely by a strong magnetic field. This arc formed part of an oscillatory circuit, including

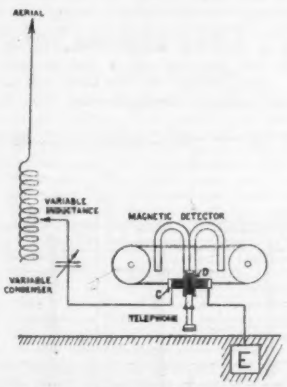



Fig. 7—SIMPLE RECEIVING CIRCUIT WITH MAGNETIC DETECTOR

a condenser and a primary coil of a high-frequency transformer, the secondary of which formed part of the radiating circuit.

It is characteristic of an electric arc that as the current increases the potential difference of the carbons decreases, or, in other words, the more current that is passed through the arc the less is the pressure difference between the carbons. Now let it be supposed that the arc be burning steadily, and the oscillatory circuit is applied to it, electricity rushes into the condenser and while it is being charged the current through the arc is diminished. The pressure difference across the arc is therefore increased and the tendency is to charge the condenser still further. When the condenser is fully charged the arc current again slightly increases, and thus causes a reduction in the pressure difference across the arc. This reduction in pressure allows the condenser to discharge itself across the arc, thus increasing the arc until the maximum current is reached, when the cycle recommences. These rapid condenser discharges produce oscillations in the radiating circuit, which are sustained by the condenser alternately drawing current from the arc and then giving it back again at the moment of discharge, the result being the production and radiation of persistent or undamped waves.

If an arc of this description could be constructed of such a size that it could deal with sufficient energy for long-distance signalling, and provided the arc could be maintained in a stable condition, then there seems to be no reason why such a system should not become popular, even though its efficiency is very low. But the arc does not remain steady, and it would seem unreasonable to expect it to do so. Its instability is caused by the carbon electrode, which is continually burning away, and this tends to keep the actual length of the arc in a state of variation which cannot be avoided even by the feeding mechanism provided. This variation in the arc results in a variation in the current flowing across it, which also means a variation in the charge given to the condenser and a consequent variation in the strength of the waves emitted. The seriousness of a weakening in the waves transmitted will become at once apparent when it is realised that if the strength of the waves is suddenly decreased, as the result of a variation in the arc, the reception of the signals at the receving station might be rendered inaudible, and probably the whole of the message would need to be repeated. The most serious objection to the Poulsen system is not, perhaps, the weakness of radiation, but the variations in the length of the waves transmitted, which result in the signals disappearing at the receiving station owing to the transmitter getting out of tune, or result in the signals inverting —that is, spaces coming through as signals instead of the dots and dashes, owing to the spacing signals getting in tune with the receiver.

### Receiving Electro-magnetic Waves.

An aerial wire absorbs some of the energy of electro-magnetic radiation falling upon it, and it absorbs best radiation of that kind and wave length which it would itself emit if set in oscillation, and absorbs it most readily when arriving in the direction in which it would itself radiate most strongly. The length of

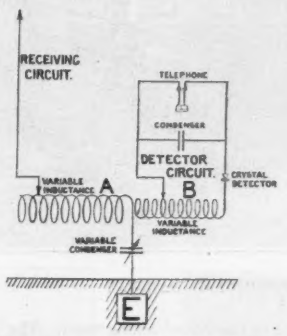



Fig. 8—TELEFUNKEN INDUCTIVELY COUPLED CIRCUIT

an electro-magnetic wave depends on the oscillation constant of the circuit, and the oscillation constant depends on the capacity of the condenser and the quantity of inductance in the circuit. Therefore all receiving stations should have embodied in their circuit a variable inductance and a variable condenser, whereby the circuit may be tuned to receive the waves radiated from the transmitting station.

The oscillations produced in a receiving circuit by the waves impinging on the aerial wire to which it is connected are not directly appreciable by our senses, and their existence can only be ascertained by the employment of detectors. When an aerial wire is to be used for receiving it may be connected directly to a circuit containing an oscillation detector, or inductively coupled to a circuit in which the detector is placed. The former and simpler method is shown in Fig. 7. Waves from the transmitting station impinge on the aerial wire, and if the variable inductance and condenser are suitably adjusted so that the wave length of the receiving circuit corresponds with the wave length of the transmitting circuit, then energy will be absorbed by the aerial wire and electric oscillations set up, which swing backwards and forwards between the aerial wire and the earth. Inserted in the circuit is a detector, which in the arrangement illustrated is of the magnetic type. This instrument is largely used by the Marconi Company, and comprises an iron band rotating in a magnetic field so as to carry the iron through a cycle of magnetic changes. When electric oscillations pass through the primary coil wound round the band, the change of the magnetic state of the iron generates an induced current in the secondary coil, and hence a current and a sound in the telephone receiver.

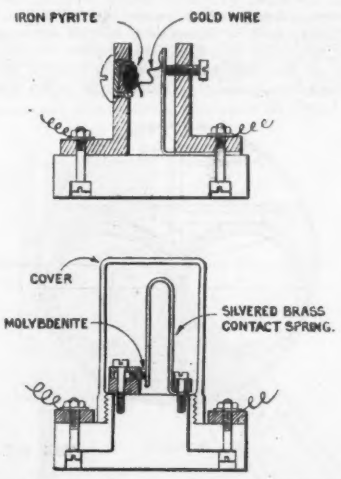



Fig. 9—SECTIONS OF TELEFUNKEN DETECTORS

Fig. 8 shows an example of a receiving circuit which is inductively coupled to the detector circuit by two coils A and B so arranged that one moves axially within the other, whereby the distance between the coils can be varied. The great advantage of a coupled circuit is the ability to eliminate waves of slightly different wave length, and thus promote sharpness in tuning, which is such a very desirable feature. For example, suppose we desire to pick out a distinctive station amongst several which may be signalling, we would first bring the coils A and B close together or slide one within the other so as to couple the two circuits tightly, and then tune the detector circuit by varying the condenser and inductance until the value of its oscillation constant approaches that of the receiving circuit, when we will hear the signals intended for us. If, however, these signals are "jammed" by signals from other stations, then the coils A and B are separated from each other and the circuits finely tuned by careful adjustment of the condensers and inductances, so that only that wave which will set the receiving circuit oscillating most violently will induce oscillations in the detector circuit. The undesired waves, which may be of slightly different frequency, will not produce oscillations in the receiving circuit of a strength sufficient to reach across the distance between the two coils A and B, and induce forced oscillations in the detector circuit.

It is obvious that this method of selectivity cannot be obtained by a simple receiving circuit in which the detector is inserted, because if the detector is reasonably delicate it is certain to be affected by all waves of approximately the same wave length, whereas with an inductively coupled circuit only that wave having a frequency identical with the natural frequency of the receiving circuit will set the circuit oscillating with sufficient intensity to induce oscillations in the loosely coupled detector circuit.

The arrangement shown in Fig. 8 is adopted by the Telefunken Company, which employs crystal detectors of the kind shown in Fig. 9, which consist of a delicate metal contact that is pressed against a suitable crystal held in a clip or holder. The action of this type of detector is not yet thoroughly understood, but certain definite facts have been established. The oscillations induced in the circuit by the waves received are similar to the oscillations created in the transmitting circuit, and produce positive and negative currents oscillating alternately in opposite directions. Now it has been found in actual practice with crystal detectors that the current in one direction passes through the crystal between the contacts to a much greater extent than the current in the other direction, and the practical effect of this phenomenon is to separate from the oscillations a direct current which passes on and produces a sound in the telephone, or may be caused to affect some other device in the circuit by which the signals can be distinguished.

Crystal detectors are also largely used by the Marconi Company, carborundum being the crystal principally employed. The arrangement adopted is shown in Fig. 10, from which it will be seen that the crystal and telephone are arranged in series

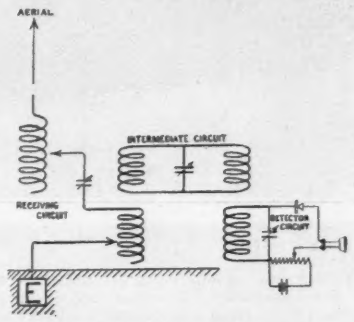



Fig. 10—MARCONI CRYSTAL DETECTOR

with a potentiometer, whereby a small current can be passed through the crystal.

With the object of still further increasing the sharpness of tuning and selectivity, the Marconi Company employ three circuits in their receiving apparatus, an intermediate circuit coupling the receiving circuit to the detector circuit. Each circuit contains a variable condenser and inductance, so that by finely tuning the circuits to the frequency of the waves to be received, and then by moving the coils in the intermediate circuit away from the coils in the receiving and detector circuits, a very loose coupling can be effected, so that only those waves having a frequency corresponding to the natural frequency of the three circuits will be able to excite oscillations in the detector circuit. The oscillations produced in a receiving circuit by a wave of different length to that wave length for which the circuit is tuned are termed forced oscillations; and, although these forced oscillations may exist in the receiving circuit, and may possibly excite oscillations in the intermediate circuit, they are quickly damped down and give way to the natural oscillations produced by the waves corresponding in length to those for which the circuits are tuned. Hence with the Marconi multiple tuner there is very little possibility of these interfering waves reaching the detector circuit and "jamming" the signals intended to be received. It should be mentioned, however, that interfering waves can only be excluded in the manner described when the waves themselves are sharply tuned. A wave having a flat tuning would probably break through all the circuits and might cause serious interference in the detector circuit by drowning out the signals which are intended to be received. According to the law in most countries, however, sharpness of tuning in the waves transmitted from stations working on commercial wave lengths is compulsory, and by means of this stipulation selectivity in wireless telegraphy is rendered possible. But in time of war laws are not considered, and it often proves of great value to radiate highly damped waves having a flat tuning so as to cause serious interference with the enemy's instruments and prevent the exchange of signals between their camps.

## IRON AND STEEL INSTITUTE.

The autumn meeting of the Iron and Steel Institute will be held in Paris on Thursday, Friday and Saturday, September 17th, 18th and 19th. A visit will be made to Nancy on Sunday, September 20th, and Monday and Tuesday, September 21st and 22nd will be devoted to visits in that district. The provisional programme of the meeting is as follows:—

*September 17th.*—Opening meeting in the hall of the Comité des Forges. A selection of papers will be read and discussed. In the afternoon visits will be made to places of interest in the vicinity of Paris. In the evening a reception will be held by the Comité des Forges.

*September 18th.*—Meeting in the morning for the reading and discussion of papers in the hall of the Comité des Forges. The afternoon will be devoted to a visit to the Basilica of St. Denis and to the works of the Compagnie des Métaux. In the evening an official reception will be held.

*September 19th.*—Closing meeting for the reading and discussion of papers. In the afternoon visits will be paid to places of technical interest in Paris.

*September 20th.*—A special train will leave Paris for Nancy, and the afternoon will be devoted to visits to places of interest in that city. In the evening a reception will be held at the Town Hall.

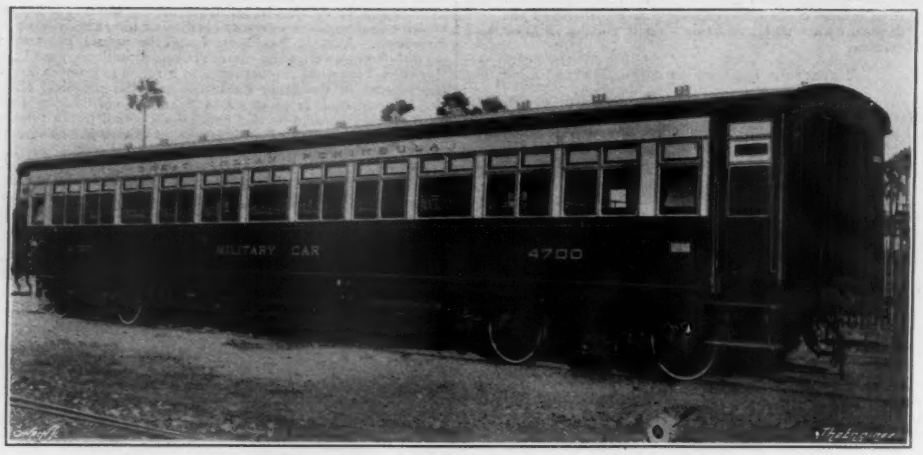
*September 21st and September 22nd.*—Visits to mines and metallurgical works in the district. On September 21st a reception will be held by the Chamber of Commerce of Nancy and the Eastern Industrial Society in the evening.

The special train will leave Charing Cross on Wednesday, September 16th, at about twelve mid-day. Luncheon will be served at Folkestone, and the time of the arrival of the party in Paris will be about 8.40 p.m. The arrangements have been placed, as on previous occasions, in the hands of Mr. G. K. Turnham. Full details will be given in a later circular, which will be posted during July only to those who have signified their intention of being present at the meeting.

The secretary's office, while in Paris, will be at the house of the Comité des Forges, Rue de Madrid.

## NEW MILITARY CAR FOR INDIA.

CONSIDERABLE attention has recently been devoted to the comforts of British troops in India, and important improvements are about to be made in the arrangements for their transport over the railways. Under the old system soldiers, landed in Bombay, were conveyed up country in ordinary third-class carriages of the type usually used for Indian passengers, by easy stages, "rest" stations or depôts being maintained at regular intervals, where the men were detrained to take their meals and




MILITARY CAR FOR THE GREAT INDIAN PENINSULAR RAILWAY

halt for a day prior to continuing the journey over another stage. Needless to say, this was a very slow proceedure, and, moreover, required a considerable amount of railway stock. Now a much quicker system is to be adopted. Upon the arrival of a military transport at the new deep-sea pier at Bombay, the soldiers will be entrained in trains of vestibuled military cars of special type, in which all arrangements are to be provided for meals, sleeping, &c. These will run through to destination with stops only for railway and locomotive purposes.

The provision of suitable vehicles for this revolution in Indian trooping has been engaging the attention of the Great Indian Peninsula Railway administration, and it turned out last year from its new Matunga carriage shops in Bombay a fine new military car possessing many novel and interesting features. It is illustrated herewith.

The car has a body 68ft. long by 10ft. wide outside, the maximum dimensions at present permissible on the

INTERIOR OF MILITARY CAR

broad gauge lines, owing to the older portions of the lines having tracks spaced at 12ft. centres—this is now being altered to 14ft. The superstructure and underframe are practically in one piece to secure the largest possible cross section without infringing the loading gauge, whilst retaining wheels of the standard—3ft. 7in.—diameter.

Burmah teak is used for the timber portion of the body framing, the pillars being supported by diagonals to the "waist" and the "top rail" tied to the longitudinals of the underframe with long through bolts. The latter part of the vehicle is entirely of steel, channel of 10 by 3½ by ½ being largely used in its construction. Between the inner and outer sheeting of the coach a layer of non-conducting sheets of "Uacolite" is introduced to protect the interior and its occupants from the heat rays of the sun. This is the usual construction adopted on the Great Indian Peninsula Railway since the abolition of the overhanging sunshades. Gauze "fly" or dust screens are provided at all the windows, as well as "Venetian" blinds.

The internal fittings consist of wood berths on galvanised steel tubular frames arranged in tiers of three, one above the other. The lowest is used as a seat by day, whilst the second folds down and forms a back rest; the third folds up clear of all. Below the lower seats are racks for standard rifles, and above the upper berths large parcel racks for kit are provided. There are sixty-six berths in all, but when these are shut up the seats can accommodate 110 native passengers, the carriage being intended for ordinary service when not required for trooping.

The water arrangements have been specially looked to, 500 gallons of water being carried in two large cylindrical galvanised steel tanks under the coach. These are so constructed that they can be easily opened and cleaned. Water is pumped to small tanks in the roof for use, and a supply of filtered water is arranged for drinking. The lavatories, two at each end, are adaptable for both European and Indian use, whilst large wash-basins enable the soldiers to have a refreshing wash. The lighting is by incandescent gas lamps, the gas being carried in reservoirs fitted with patent safety valves, which automatically close and prevent any escape of gas in the event of damage to the piping or fittings. The lamps can be turned up or down from the corridor. Thorough ventilation has been provided for by a row of "Venetians" introduced above the windows, which can be opened—or closed entirely during the monsoon season by shutters—acting in combination with a double line of "Monarch" air exhausters arranged down the centre of the roof. The result is a current of air from the sides of the coach towards the middle.

The cars are intended to run, when in trooping service, closely vestibuled, together with a canteen car at the centre of the train, the meals being served to the soldiers at regulated times by orderlies deputed to the work. For the accommodation of officers a corridor sleeping car is to be provided on each train, and baggage will be stored in vans. Each train will transport half a regiment with complete kit and equipment. The cars are from the designs of Mr. A. M. Bell, the carriage and wagon superintendent of the Great Indian Peninsula Railway.

## THE "C.K" FEED-WATER DIFFUSER.

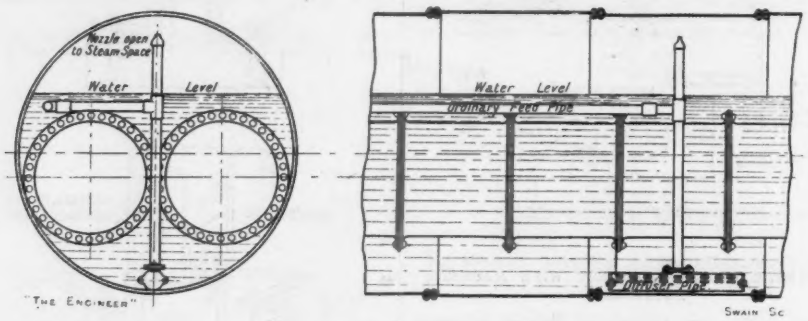
A NEW method of feeding boilers, which is the subject of a patent, has recently been introduced by Holdsworth and Sons, Limited, of Croft Boiler Works, Bradford. The apparatus employed is known as the "C.K" feed-water diffuser, and is illustrated in the accompanying engraving, as applied to a Lancashire boiler. In explaining the action of this diffuser Messrs. Holdsworth point out that (*a*) heat transmission is more rapid when the water above a unit of heating surface is in a state of active ebullition than when it is stagnant; and (*b*) that ebullition, or boiling, can only take place above the furnace level.

In view of these two points, they urge that present methods of feeding boilers are entirely wrong, and must, of necessity, interfere both with the duty and efficiency of the boiler. The feed-water pipe in a Lancashire boiler is at present carried on one side of, and a few inches above, the top of the furnace flues, and is, as a rule, perforated for about 6ft. or 8ft. Messrs. Holdsworth assert that the objection to this method is obvious, as, no matter at what temperature the water is entering the boiler, its discharge above the furnace level must minimise the rate of ebullition, and hence the duty of the boiler, and that a large proportion of the salts and lime in the water must settle on the furnace flues and form a hard scale.

In the "CK" diffuser the water passes along the present feed pipe for about 15ft. feed, and is then carried with a bend and coupled at right angles to a vertical pipe passing between the furnace flues. The upper part of this vertical pipe is open and is carried well into the steam space, while the lower portion terminates in a receiver which is perforated on its upper side and which rests on the shell of the boiler. Since the vertical pipe is open to the steam space, syphonic action from the boiler due to leaky check valves, is entirely prevented, and boilers at various levels may be worked with a common feed.

The action of the diffuser is as follows:—The feed water, as it passes from the horizontal to the vertical pipe, is acted upon by the live steam, and the precipitation of any foreign matter that there may be in the water is thereby assisted. The foreign matter, salts and lime are precipitated to the bottom of the receiver, while the purified water escapes through the perforations at the top. The receiver is provided with a door at each end, so that the precipitated matter can be removed when the boiler is laid off for cleaning.

A good many claims are put forward for this apparatus, among which we may mention the following:—(1) The removal of the lime, salts, &c., from the water assists in keeping the boiler cleaner, especially the furnace flues; (2) as the water enters near the bottom and slowly rises, it is being gradually qualified for producing steam quickly as soon as the ebullition area is reached; (3) by taking water to the bottom before liberating it a constant temperature may be maintained and the troubles due to unequal expansion and contraction are entirely removed; and (4) the discharge of water at the lower level has a beneficial effect on the circulation throughout the boiler and prevents stagnation.




THE C.K. FEED-WATER DIFFUSER

## THE AQUITANIA.

WE give on page 622 two views of the Aquitania. They are reproduced with the object of showing the disposal of the boats and to bring home to the reader the amount of space that is taken up. It will be seen that the boat deck is practically full of boats, and that there is little or no chance of using it as a promenade. How frightened passengers are to be got into the boats in such a crowded position is a question which we trust may never be put to the test. We described the ship fully in our last issue.

## THE ELDICK LATHE CUTTING-OFF TOOL.

A NEAT little tool for cutting-off portions of the same length from a bar of material being dealt with in a hollow spindle lathe has just been brought to our notice. It has been patented and is made by the Motogear Engineering Company, of Ilford Hill, Essex, which has named it the Eldick. It has very much the form of a pair of nut crackers, the two arms of which are normally kept apart by a small coiled spring, but can be closed—just as though a nut were being cracked—by closing the hand holding the tool. An adjustable stop enables the travel of the arms to be regulated within certain limits. The top arm is cast with a lug, having a hole machined in it for carrying a bush which is clamped in position by a butterfly nut, the lug being split to allow of this. The axis of the bush is parallel to the axis of the pin of the hinge connecting the two arms of the tool. This pin is prolonged and serves two purposes. It carries first of all a fixed cutter, and next a spindle, up and down which slides an arm for regulating the length of material which is to be cut off. The cutter has three teeth arranged at 120 deg. apart from one another, but only one tooth is employed at a time, the others only coming into use when the first tooth becomes blunt. The cutter is clamped in position by a nut which it is necessary to slack out when it is desired to use another tooth. To cut off a portion of the work, the end of the bar—which, of course, is revolving—is inserted through the bush till it comes up against the stop, and the two arms of the tool are then gripped together. The result is that the tooth of the cutter is gradually forced into the material till it has severed it from the main rod. The position of the bush can be so arranged that its end may be brought very near indeed to the cutter, and the work is thus supported practically right up to the cutting edge. This has been done in order to eliminate chatter, and it has the effect of keeping the cutting edge sharp for a longer time than would otherwise be possible. The tool, which is provided with a series of bushes for work of different diameters, is exceedingly well made, and should prove useful to those who are engaged in the reproduction of small metal parts. It is claimed that since the tool has not got to be put in and out of the slide rest, the machining tool may remain in position, so that work can be turned out with a plain turning lathe with the same rapidity as with a capstan lathe.

WE have received a communication from the Middleburg Steam Coal and Coke Company, Limited, from which we learn that it has recently completed a new borehole for water, which has been taken down to a depth of 235ft. The borehole yields 10,000 gallons per twenty-four hours. At a depth of 72ft. a seam of clean coal 13½ft. thick was encountered.

# THE ASSOUAN DAM

Fig. 1—HEIGHTENING MASONRY

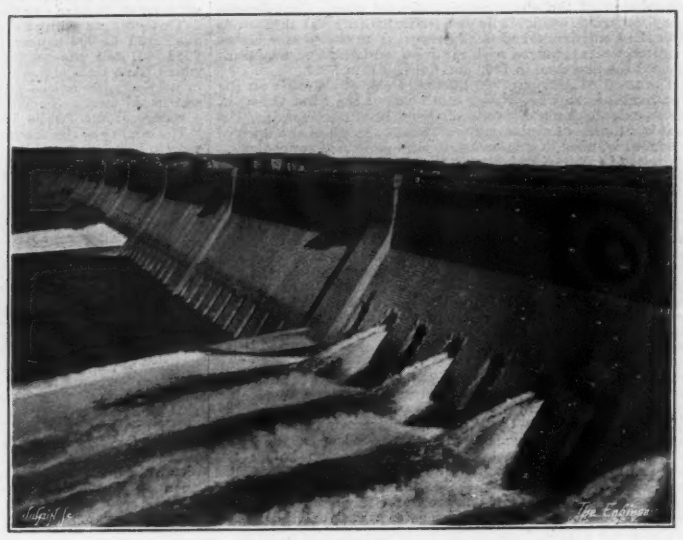


Fig. 2—OPEN SLUICES, LOOKING EAST

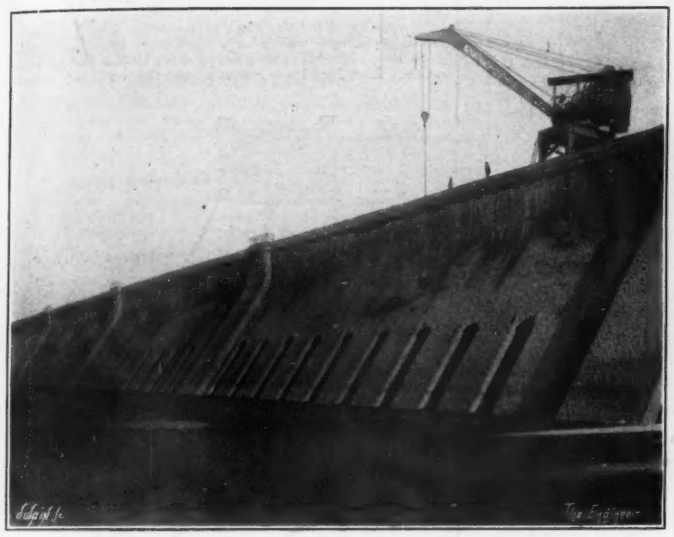


Fig. 3—FACE OF DAM SHOWING SEEPAGE

Fig. 4—BLOCK OF GRANITE RAISED BY WATER

## THE ASSOUAN DAM.*

By MR. R. HOLT, President.

WATER supply for the purpose of irrigation is a matter of prime importance to Egypt. The yearly flood waters of the Nile due to rainfall in Abyssinia and the equatorial regions commence to arrive at Assouan about the end of June, and increase rapidly until the maximum level occurs about the end of the first week in September, after which there is a more or less rapid fall during the months of October and November, the fall continues at a lower rate until the middle of May, when the Nile is at its minimum level at Assouan. The amount of rainfall north of Assouan is practically a negligible quantity.

The cultivated land of Egypt comprises the Delta in the shape of a triangle with one side on the Mediterranean coast and an apex at Cairo; after this the cultivated part extends in varying width on either side of the Nile as far as Halfa at the north end of the Second Cataract, a distance of 1550 kiloms. from the Mediterranean Sea. To the south-west of Cairo there is a large cultivated area in the oasis of the Fayoum, which obtains its irrigation water supply from the Nile by way of the Yussef Canal. In recent years the increase of cultivation, especially of cotton, has created a demand for an increased water supply during the months when the natural water supply of the Nile in ordinary circumstances is small.

To provide this extra supply in spring and early summer the Egyptian Government decided to make in the Nile Valley a reservoir to store during the latter part of the flood season some of the river water which otherwise runs into the Mediterranean Sea. This reservoir was formed by the construction of a large dam about the middle of the First Cataract south of the town of Assouan. From the commencement of the work of construction up to the present time I have been able to make a visit at least once a year to this remarkable work, which has been achieved by an exceptionally capable body of engineers. As a visitor interested in engineering matters, permission has always been freely given to me to examine all that was being done. The following is a brief description of a few of the many points of interest in connection with the construction and a review of several matters which have been somewhat carelessly criticised.

It may not be altogether out of place in the first instance to refer to a much misunderstood point, viz., who originated the idea that a dam should be constructed at the First Cataract, near Assouan?

Amongst the well-known explorers of the Nile and its sources the name of Sir Samuel Baker stands prominent, his books of travel and observations being extremely interesting.

One volume in particular, entitled "The Nile Tributaries of Abyssinia," dated May 8th, 1861, starts with a description of the neighbourhood of Philae. Towards the end of the book he suggests the construction of a dam at the First Cataract, near Assouan, in the following words:—"With a river that supplies an unlimited quantity of water and mud at a particular season a supply could be afforded to a prodigious area that would be fertilised not only by irrigation, but by the annual deposit of soil from the water allowed to remain upon the surface. This suggestion might be carried out by gradations. The great work might be commenced by a single dam above the First Cataract at Assouan, at a spot where the river is walled in by granite hills. At that place the water could be raised to an exceedingly high level that would command an immense tract of country. By raising the level of the Nile 60ft. at every dam the cataracts would no longer exist, &c. &c." It is now fifty years since Sir Samuel Baker suggested the building of a series of dams and the amount (60ft.) to which the river level should be raised at Assouan. The first Assouan Dam was built on the site and to the height suggested by Sir Samuel Baker. No one other than the great explorer can thus lay claim to having originated the idea.

It is a curious coincidence that the consulting engineer for the dam had a similar name to that of the great explorer. The late Sir Benjamin Baker, of world-wide renown, so well known in the engineering profession as a man of the highest merit, was responsible for the construction, right up to the time of his death, which occurred when the dam was in process of being increased in size for the purpose of making the reservoir larger. All his works are examples of the very first order of soundness and skill, some of them being among the wonders of the world. An international Commission, consisting of Sir Benjamin Baker, Signor Torricelli, and M. Boulé, considered the project of construction of a dam at the First Cataract in 1894. The Government engineers submitted to the Commissioners designs for a

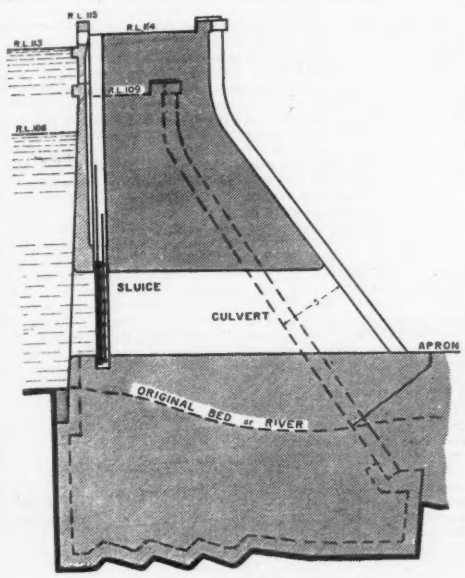



Fig. 5—STONEY SLUICE

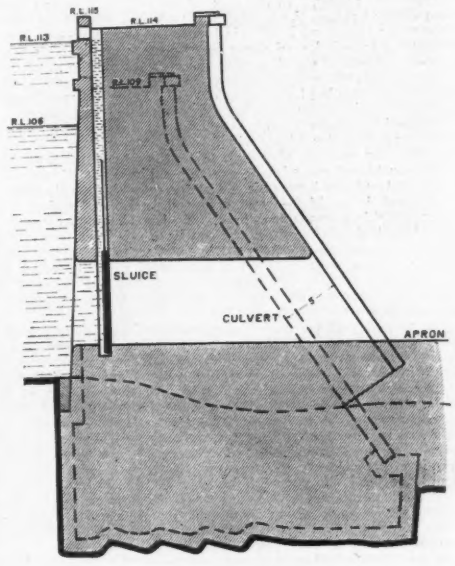



Fig. 6—ORDINARY SLUICE

* Paper read before the Association of Engineers and Architects, Cairo, 10th May, 1914.

curved series of dams forming a broken alignment which they were unable to accept. A straight alignment was considered more desirable, and a new design to meet this suggestion was then submitted, which the Commission finally approved after making further alterations in regard to the thickness and general shape of the work. It may thus be said without the slightest doubt that the dam actually built is that suggested by the Commission of the above-mentioned able men. Considerable delay occurred owing, it is believed, to financial difficulties after the Commission had finally reported on the scheme before a contract was arranged with Sir John Aird and Co., who commenced the first dam in 1898 and finished it in 1902.

The town of Assouan, 950 kiloms. south of Cairo, is on the east bank of the Nile, at the north end of the First Cataract, which extends for a distance of about 10 kiloms. south. The dam is situated at a place about 6 kiloms. south of the town of Assouan. Owing to a deference to the opinions of archæologists interested in Philae, an island in the river about 2 kiloms. south of the dam containing a very valuable temple of antiquarian interest, it was decided to fix the highest water level in the reservoir at the dam at R.L. 106 m. (above mean sea level at Alexandria), the top of the parapet to be R.L. 110 m. The original Assouan Dam was built to these levels, and the foundation is on the granite rock which forms the bed of the river. The foundation level was obtained by excavation of the bed rock to an average of about R.L. 83; at one place excavation was carried as low as R.L. 70.25. Considering R.L. 92.5 m. as an average of the original river bottom, some idea can be formed of the thorough manner in which the rock was excavated in order to reach a sound foundation.

The dam reaches from one side of the river to the other in a straight length of 2000 m., of which a length of 450 m. at the east flank is solid, the remainder being pierced by 180 culverts, each 2 m. wide; 40 of these culverts are 3.5 m. high, and the others are 7 m. high. Forty of these culverts were lined with massive cast iron plates; this lining was used when rapid progress with the work was necessary each season before the cessation of operations caused by the rising Nile. Winches fixed permanently on the top of each sluice well at the side of the roadway on top of the dam are worked by hand power, and are employed for moving the sluice gates in each culvert. Each

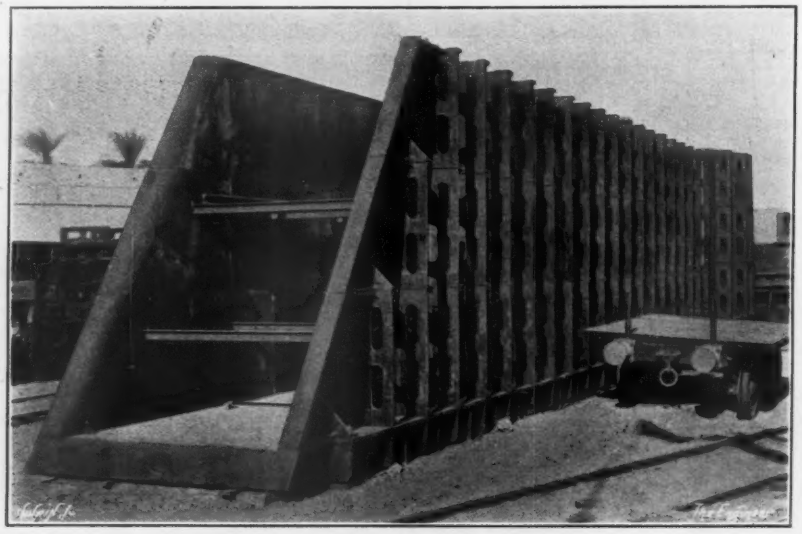


Fig. 7—CAST IRON LINING FOR SLUICE

of the large gates weighs as much as 14 tons. Some of the gates are of the ordinary type and slide on a bearing surface. Others are provided with Stoney's patent roller arrangement, and are particularly easy to manipulate.

The Stoney gates make a joint on the upstream face of the containing grooves. To prevent leakage an iron rod freely suspended in the sides and top of the upstream face is kept in place and forced into position by the water. It will be noticed in Fig. 5 that the reservoir water does not rise in the sluice well, and consequently has no opportunity to force its way through the mass of the masonry on the downstream side of the sluice well at these places. In the case of the ordinary sliding sluice gates without rollers the condition is reversed, and water stands in the well to the same level as it does in the reservoir—see Fig. 6. Without a knowledge of these facts remarks have been made that some parts of the dam showing seepage on the north face are not sound, while other parts not showing seepage are sound. This is an example of the mistake made by critics who formed opinions based on unsound, hasty, or careless observation.

Situated at the west flank of the dam is a series of four locks each 80 m. long by 9½ m. wide, the upstream lock sill being R.L. 90. On account of the great depths and water pressures, it was considered not advisable to depend on the ordinary form of lock gate of two leaves hinged at the quoins. Single gates—the largest 19 m. high—were designed to be suspended from girders reaching across each lock. Each gate reaches from one side of the lock to the other, and can be drawn back into a large recess at right angles to the walls, the girders being subsequently raised swinging vertically on a horizontal pivot to allow the passage of vessels. The whole arrangement is worked by means of hydraulic machinery, and requires the attention of only one man.

The masonry of the dam is of selected red granite quarried in the neighbourhood. Both the rubble and the ashlar was as large as could be conveniently handled, the former by men and the latter by 2½ ton cranes. Portland cement mortar—two sand to one cement—was used throughout for the masonry of the ashlar sluices, the upstream face and for the first layer of 60 cm. of masonry on the bed rock; the "hearting" generally was built in 4 to 1 cement mortar. Careful testing showed that the cement mortar averages about 40 per cent. of the whole mass of the masonry. By the end of July, 1902, the original dam was completed, and the reservoir started to fill in October, 1902. The total payment to the masonry contractors was about £2,000,000, though where land expropriation, iron work, and other contracts and expenditure is included the whole work actually cost £3,237,265.

After the dam had been in service for a short time it was found that the water discharged through the culverts had a severe action on the river bed downstream of the dam. Fissures and holes appeared where the water scour was severe, and loose rocks were moved a considerable distance. One block of granite rock lifted from the river bed by the water discharging from a culvert weighed about 100 tons—see Fig. 4. In 1903 protective works in the form of heavy masonry aprons were commenced. The work proved so efficient that the Government decided to provide similar protection opposite all the culverts. These aprons were built on the granite rock of the river bed, the loose parts of which were removed by blasting in some places to a depth of as much as 11 m. The whole was filled with rubble masonry in 4 to 1 cement mortar. Masonry in 6 to 1 cement mortar was used for the lower levels of the greater depths when these were distant 7 m. or more from the dam. The top surface of the apron is of selected granite sets in 2 to 1 cement mortar, built up to a level of 15 cm. below the level of the culvert sills and extending in a slope downstream for a distance, in some cases, of 60 m., to meet the bed of the river.

This work, totalling 136,000 cubic metres of masonry "hearting" and 61,000 square metres of "facing," cost altogether £282,705, and was completed in July, 1906. The eight years which have since elapsed have given opportunity for trial and inspection sufficient to prove the solidity and efficiency of this additional work. Sir William Garstin, when referring to it in a report of the Public Works Department of Egypt, said:—"The quality of the masonry is of the highest class. It must be seen to be appreciated."

After the original dam had been working for several years the benefit to the country of the addition of the stored waters to the ordinary supply was so marked that it was proposed to go even further and provide additional storage. To obtain this the Egyptian Government decided to increase the size of the dam by raising the parapet to R.L. 115 (5 m. higher), so as to raise the reservoir water level to R.L. 113 (7 m. higher). This has increased the storage capacity of the reservoir nearly two and a-half times. The reservoir at R.L. 106 had a storage capacity of 980,000,000 cubic metres—say, 216,300 million gallons—and a length of 230 kiloms.—say, 143 miles—*i.e.*, as far as Ibrim. The raised reservoir at R.L. 113 has a capacity of 2,420,000,000 cubic metres—say, 534,100 million gallons—and a length of 295 kiloms.—say 183 miles—*i.e.*, it extends to a short distance beyond the Abu Simbel Temple.

The additions to increase the size of the original dam were devised by the late Sir Benjamin Baker, about whom the following note appears in the Public Works Department Irrigation Report for Egypt for 1908:—"The lamented death of this distinguished engineer has deprived the Egyptian Government of a valued counsellor and adviser. He was consulted by us upon all questions connected with the construction works of the Nile reservoir. It is a satisfaction to know that he was able before his death to visit Assouan and to pronounce, in the strongest terms possible, a favourable opinion upon the stability and solidity of the great dam. It is equally satisfactory to know that Egypt has been able to obtain such a valuable result of his genius as his design for the raised dam."

The original reservoir supplied the wants of Middle Egypt. The raised reservoir enables extra water to be supplied to Lower Egypt. Before raising the dam it was considered advisable to increase the width of the section. The Egyptian Ministry of Public Works finally decided to add a 5 m. thickness of masonry to the north face and to the top of the original dam. This mass of masonry is referred to as the "thickening" and "heightening."

By the advice of Sir Benjamin Baker a space of 15 cm. was to be left between the "thickening" and the original dam before they were finally joined. New masonry was supported in this position by mild steel rods 32 mm. diameter and 2½ m. long, placed in holes bored in the original dam at right angles to the downstream surface at every metre; the 15 cm. space was provided with perforated iron pipes placed in suitable positions to grout the "filling," which consists of broken granite—see Fig. 1.

Before commencing the masonry of the "thickening," foundations were excavated in the solid rock—in some places even to a lower depth than the original dam. On the sound foundation so obtained the masonry of the "thickening" was built up to a level a little below the roadway of the original dam, the roadway and parapets of which were removed before the addition of the "heightening"—Fig. 8. The "thickening" remained isolated from the original dam by the 15 cm. space for two years, to allow the temperature of the new masonry to become normal and equal to that of the original dam. After this two-year interval the "grouting" of the 15 cm. space was taken in hand, and afterwards the "heightening" was added. Corresponding changes were made in the lock walls, and one extra lock constructed, making the total number five. The upper gate weighs about 125 tons.

The whole construction is truly magnificent, sound, and solid. That the work has been under the direction of such an able engineer as Mr. Macdonald is a guarantee in itself that everything has been carried out with all the perfection possible at the present day. Notwithstanding the excellence of the truly marvellous results of the work done by the engineers who have been directly connected with the construction of the Assouan Dam, flippant, foolish rumours have been set going about its construction and soundness. Among the extraordinary statements which appeared are the following:—The dam is leaking like a sieve; parts of the dam show settlement; linings of some of the culverts are working loose, &c. &c. In fact, the general public reading such must have commenced to think that the Assouan Dam would be useless in a few months. I think the detractors will have to wait a few thousand years and more. They would probably like to announce the collapse of the Pyramids and suggest the proper way to build them. No one has ever seen the Assouan Dam "leaking like a sieve" or anything approaching it.

On July 4th, 1913, the reservoir level was R.L. 104.21; on January 21st, 1914, the level was R.L. 113.50, *i.e.*, 30 cm. above the sill of the spillways. To retain this extraordinary water level the spillways were closed by heavy timber boarding. By this means an additional depth of 50 cm. of water has been stored in the reservoir to provide an extra supply of water for irrigation purposes. I was at the Assouan Dam on the dates mentioned and at other times, and nothing more than a small amount of "seepage" producing little more than dampness was to be seen, although the reservoir was full to more than ordinary maximum level. This percolation or "seepage," which is of the nature to be expected, amounts to the appearance of moisture in a few places on the downstream face; dust-laden wind deposits dust which makes such places easily visible—see Fig. 3. Engineers know very well that "seepage" will take place, and that it generally disappears as the work ages.

In looking up records of big dams constructed in different parts of the world "seepage" is invariably evident. Edward Wegmann, author of "The Design and Construction of Dams," consulting engineer to the city of New York water supply, and who had much to do with the well-known New Croton Dam, writes as follows:—"However carefully the masonry be laid, a certain amount of leakage will always take place in a dam. Again, water that passes through a thick masonry dam and only shows itself as a moist spot on the downstream side can scarcely be considered to cause an upward pressure on the masonry. On the contrary, in passing through the pores of the stones and mortar it increases the weight of the masonry, and consequently the stability of the dam."

It is scarcely necessary to say more about the absurd rumours that the "seepage" necessarily meant weakness.

Again, it has been declared that water passes as a leakage under the old dam, then up the grouted space, and finally issues at the level of the under-surface of the "heightening" on the downstream face; this is, of course absurd, and no one with the slightest engineering knowledge of the structure could be expected to make such a statement. The small amount of "seepage" which appears at one or two places near the base of the "heightening" at R.L. 108 is undoubtedly coming in a more or less horizontal direction through the mortar.

It has been stated that over a length of 200 m. in the solid part of the dam leakage was so bad that settlement took place. The whole seepage gathered together amounts to only 14½ gallons (.6588 cubic metre) per hour, as carefully measured, or one-sixteenth that of the Gileppe Dam in Belgium, which has been working since 1875. As regards "settlement," it is scarcely necessary to mention that after the closest and most carefully personal examinations in which I cut into the dam wherever I thought necessary, employing stone cutters under my personal supervision for this purpose, I am able to say that there is no evidence of any kind whatever on which to base such an assertion.

As mentioned before, some of the lower level culverts have cast iron linings, which have also been adversely criticised. It has been stated that they are working loose; there is no truth in this. Last July I was lowered down the north face of the dam

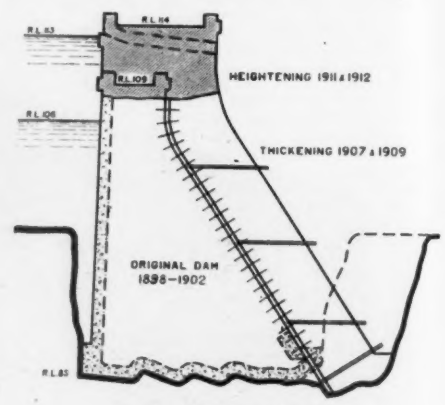



Fig. 8—HEIGHTENED DAM

by means of one of the cranes and entered the lined culverts—see Figs. 2 and 7. The linings are in perfect condition. There is no sign whatever of deterioration; the head of water above the culvert floor was 26 m. at the time I made this inspection.

The locks, lock gates, and the mechanism seem to have escaped criticism up to now.

At the site of the dam temperatures as low as 40 deg. Fah. have been observed during January, and as high as 125 deg. Fah. shade temperature in summer. The annual average daily range of temperature is about 37 deg. Fah. Considering the great length (2000 m.) of the dam, it is easily foreseen that temperature changes must produce some visible effect. Temperature cracks are therefore unavoidable. On several occasions I closely examined the masonry of the downstream face of the dam and found many cracks, all of which are practically vertical: the majority very fine hair cracks, only seen by very close examination; they are not very apparent and show no leakage whatever. Especially in the east end of the dam for a length of about 450 m., where there are no culverts, the cracks have spaced themselves with remarkable regularity. This in itself is testimony to the uniformity of the structure.

The fine hair cracks referred to are in the "thickening." They do not correspond exactly with similar hair cracks in the original dam, so the masses of the "thickening" between the cracks act in some sense like cover plates. This is a matter which no doubt was foreseen when devising the whole construction. If the cracks were open ones passing without interruption completely through (1) the original dam, (2) the cement-grouted space, (3) the "thickening," no doubt water would pass to a greater extent than the "seepage" which can be seen, and which is not passing between stones or the cracks, but through the mortar.

During the past year much criticism has been made on the subject of the foundation of the "thickening," and special attention drawn to the solid end of the dam. It was mentioned that sections published in the Egyptian Government irrigation reports were in some way misleading, and not correct. As an outside engineer interested in watching the growth of this magnificent work right from its commencement, it seemed to me that such imputations were not likely to be based on fact.

I tried to fathom the criticism. After reading them carefully several times and comparing closely the irrigation reports which were referred to, I was forced to the conclusion that there was nothing whatever in the line of argument, and that it was based on a misconception of the facts, which perhaps might have been better understood if they had been studied carefully. To assure myself that such was the case I obtained copies of sections from the "progress" plans and carefully examined them.

Another astounding statement was that the downstream face of the dam had a "patch" built on to prevent leakage. It appears that an experimental piece of "grouting" made before the grouting of the 15 cm. space between the old and new work was taken in hand had actually been mistaken for an attempt to stop leakage. Surely, comment on such a remark is scarcely necessary.

I would like to mention, before finishing, that the total mass of masonry in the original dam is over 1,000,000 tons, and that the volume of the dam as it is to-day is about one-third the volume of the Great Pyramid. This latter fact, I am afraid, does not

give a good idea of the magnitude of the dam, but rather of the Great Pyramid.

In conclusion, I wish to express my thanks to Mr. Macdonald, Under-Secretary of State, Public Works Ministry, who very kindly gave me facility to visit the works at all times and see everything that I wished to examine. Mr. MacCorquodale, late resident engineer of the dam, and Mr. Watt, the present director, very patiently furnished me much information. I think the Egyptian Government have a great deal for which to thank Sir Benjamin Baker, Sir Arthur Webb, and Mr. Macdonald in connection with the splendid work they have carried out at Assouan.

## FORTHCOMING ENGAGEMENTS.

### TO-DAY.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. The discourse will be delivered by Professor William H. Bragg, F.R.S. The subject is "X-Rays and Crystalline Structure." 9 p.m.

### FRIDAY AND SATURDAY, JUNE 5TH AND 6TH.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Visit to Dunfermline. For programme see page 606.

### MONDAY, JUNE 8TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. General meeting. 5 p.m.

### TUESDAY, JUNE 9TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH LOCAL SECTION.—Annual summer outing. Leave Central Station, Glasgow, for Wemyss Bay at 9.30 a.m., thence per steamer *vid* Kyles of Bute to Arran, arriving Whiting Bay at 1.40 p.m., returning at 2 p.m. *vid* Garroch Head.

RONTGEN SOCIETY.—At the Institution of Electrical Engineers, Victoria Embankment, W.C. Annual general meeting. Exhibition of apparatus. Short papers and demonstrations by Dr. Rodman, Messrs. Chambers and Rankin, Mr. Clarke and others. 8.15 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. The following papers will be read:—"Review on Mining Legislation," by Mr. A. Dury Mitton; "Removal of Carbon Monoxide from Air, and Methods of Estimation in Mines," by Mr. John Harger. 4 p.m. The Council will meet on the same day at 3 p.m.

### WEDNESDAY, JUNE 10TH.

NOTTINGHAM SOCIETY OF ENGINEERS.—Evening visit to Radford Gasworks, where an installation of vertical retorts (continuous carbonisation) has recently been put into operation. At 7 p.m.

### THURSDAY, JUNE 11TH.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. "Faraday and the Foundation of Electrical Engineering," by Professor S. P. Thompson, F.R.S. 3 p.m.

THE FARADAY SOCIETY.—Ordinary meeting at the Institution of Electrical Engineers, Victoria Embankment, London. The President, Sir Robert Hadfield, F.R.S., will deliver his presidential address on "Advances in the Metallurgy of Iron and Steel." 8 p.m.

### THURSDAY TO SATURDAY, JUNE 11TH TO 13TH.

THE INSTITUTION OF WATER ENGINEERS.—Summer meeting at Stockport. For programme see page 578.

### FRIDAY, JUNE 12TH.

THE ROYAL INSTITUTION OF GREAT BRITAIN:—Albemarle-street, Piccadilly, W. "Some Aspects of the American Democracy," by the Hon. W. H. Page, LL.D., the American Ambassador. 9 p.m.

PHYSICAL SOCIETY OF LONDON.—At the Imperial College of Science, Imperial Institute-road, South Kensington. "Note on the Connection between the Method of Least Squares and the Fourier Method of Calculating the Coefficients of a Trigonometrical Series to represent a given Function or Series of Observations," by Professor C. H. Lees, F.R.S.; "A Magnetograph for Measuring Variations in the Horizontal Intensity of the Earth's Magnetic Field," by Mr. F. E. Smith; "The Atomic Weight of Copper by Electrolysis," by Mr. A. G. Shrimpton; "Note on an Improvement in the Einthoven String Galvanometer," by Mr. W. H. Apthorpe. 8 p.m. Editing Committee meeting at 7 p.m. Council meeting at 7.30 p.m.

### MONDAY TO SATURDAY, JUNE 15TH TO 20TH.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.—Nineteenth annual Convention at Birmingham. For programme see page 566.

### WEDNESDAY, JUNE 17TH.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS, LONDON.—At Caxton Hall, Westminster. "The Evolution and Development of the Internal Combustion Railway Locomotive," by Mr. W. P. Durtnall. 7.30 p.m.

### TUESDAY, JUNE 16TH, TO FRIDAY, JUNE 19TH.

INSTITUTION OF GAS ENGINEERS.—Annual general meeting at Liverpool. For programme see page 620.

### SATURDAY, JUNE 20TH.

PHYSICAL SOCIETY OF LONDON.—Visit to the Cavendish Laboratory, Cambridge. The directors of the Cambridge Scientific Instrument Company have invited the Society to visit their works. Leave Liverpool-street Station for Cambridge, 9.10 a.m.; travel by special motor omnibuses to the works of the Cambridge Scientific Instrument Company, arriving at 11.10 a.m.; visit to colleges, &c., 2 p.m.; visit to Cavendish Laboratory, 3 p.m.; tea by invitation of Lady and Sir J. J. Thomson, 4.30 p.m.; meeting of the Society in the Cavendish Laboratory, 5 p.m.

## THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

*(From our own Correspondent.)*

### State of Trade.

THE holidays have monopolised attention this week, and very few works have been running in the manufactured iron trade. Such as have been operative did not start until the week was fully half gone, and the bulk will remain shut down until Tuesday or Wednesday of next week. The attendance on 'Change in Birmingham to-day—Thursday—was very meagre, and the business done was purely nominal. Ironmasters took advantage of the flat state of trade to remain away from the market in large numbers, and it is safe to predict that even next week will see little recovery.

### Manufactured Iron Trade.

Manufactured iron masters are this week assisted a little by a further reduction just decreed of 2½ per cent. in ironworkers' wages, bringing puddling down to 9s. 9d. per ton, and millmen's wages in proportion. This relief is not, however, sufficient to compensate them for the continuous fall in prices. Common bars have now got down to as low as £6 2s. 6d. to £6 5s. per ton delivered locally, and merchant bars are no more than £6 10s. to £6 12s. 6d. delivered Birmingham. Plain black sheets are this week quoted £7 15s. per ton for doubles, and £8 7s. 6d. trebles, while galvanised sheets are only commanding £10 15s. to £10 17s. 6d. for 24 w.g. material for export. Home orders are anything between £11 and £11 5s. Hoops are quoted at £7 to £7 5s. nominal.

### Tube Strip Makers' Matters.

A very pertinent matter of discussion on Birmingham Exchange continues to be found in what is going on in connection with the tube strip trade. Unofficial members of the Makers' Association are quite frank that, as was stated in this letter two weeks since, the Association has for all practical purposes now been dissolved. Officially what has been done is "to appoint a Committee to settle the preliminaries," but it is generally understood that the last general meeting has taken place. The combine was originally mooted in July, 1901, when a long strike in the wrought iron tube trade had severely depressed prices, which then stood at only £6 7s. 6d. per ton. The highest price level reached during the fourteen years' existence of the Association was in December, 1912, and January, 1913, when values went up to £8 10s. and £8 12s. 6d. per ton. Lately, firms outside the combine, by price cutting, have been getting all the business, and this circumstance, added to severe Belgian and German competition, has now led to the withdrawal of the organisation. The final Association quotation—only three weeks since—was £6 10s. to £6 12s. 6d. per ton, but this week good orders can be placed at £6 to £6 5s. per ton.

### Pig Iron.

Blast furnaces in the Midland district have been blown out or damped down during the past few weeks to such an extent that the pig iron output is now little more than enough to meet demand. Buying is still almost entirely confined to small parcels, and the Birmingham market is very lifeless. Prices show no quotable change on the week on the basis of 50s. to 51s. for South Staffordshire forge iron, 51s. to 52s. for Staffordshire part-mine iron, 85s. to 90s. for best all-mine forge, and 92s. 6d. for foundry. Midland pigs are:—Northampton forge, 47s. 6d. to 49s.; and Derbyshire, 50s. 6d. to 51s. 6d. per ton.

### Engineering Trades.

The engineering yards engaged in the bridge and roofing, steam boiler and tank industries in this district keep steadily engaged on old contracts, but new business is not arriving as well as could be desired by any means. The makers of chain cables and anchors and similar ship's accessories have for a long time been busy, but no overtime is now being worked, and it is thought that demand is likely further to fall off. The common chain trade is also less active at date.

### Iron Trade Wages.

For ten months now the remuneration of labour in the mills and forges and at the blast furnaces in all the iron-making districts of the kingdom has been steadily falling, and it seems likely that the drop will go on. It was in July of last year, after a considerable period of inflation, that wages commenced to fall, and the latest returns of the Wages Boards which regulate the industry in the North of England, in Lancashire, the Midlands and South Wales show that the tide is still running out. In all the districts named a fresh reduction of 3d. per ton, or 2½ per cent., in wages has this week been decreed at the blast furnaces and at the rolling mills and puddling forges in the manufacturing iron works, making the total reduction in wages since the decline set in 15 per cent., or 1s. 6d. per ton, in puddlers' wages, and millmen's in proportion. High-water mark, it is interesting to recall, during the late boom was reached just twelve months ago, when puddlers' wages in Staffordshire and Lancashire and South Wales touched 11s. 3d. per ton, and in the North of England the remuneration was exactly proportionate. Now Midland and Welsh wages are down to 9s. 9d. per ton for puddling, and on the North-East Coast they are about the same. How ironmasters' profits have been affected by the change which has come over the state of demand throughout the entire country since June of last year is sufficiently shown in the circumstances that the net average ascertained selling price of all classes of manufactured iron in the Midlands and Lancashire and South Yorkshire for the biennial period just twelve months since was £8 7s. 11d. per ton; for the first two months of this year the figure had dropped to £7 4s. 10d. per ton, and the net average declared this week is only £7 0s. 11d., showing a decline during the ten months of 27s. per ton. In the Cleveland district the decline has been almost equally pronounced, and during the first four months of this year alone—no later returns are available—the average selling price has lost 8s. per ton, having fallen from £7 2s. 9d. to £6 14s. 9d. at date. It is a suggestive circumstance that to arrive at a similar net average selling price in the Midlands and Lancashire district to that which now obtains we have to go back a couple of years, when the declared net average was only 5d. per ton less than it is to-day. How long the trend of trade in the iron districts is to continue as it is at present found, it is impossible to say, or what minimum in respect of wages and ironmasters' remuneration alike will be touched. The existing state of things is, of course, unsatisfactory, and calls for the exercise of patience not unmixed with hope on the part of all concerned in the industry.

## NOTES FROM LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

### Whitsuntide Holidays.

LANCASHIRE with the advent of Whitsuntide has assumed a holiday appearance, and the attendance on the Iron Exchange on Tuesday was relatively small. There was practically no change to note in any department, with the exception of copper, which was rather weaker, and English tin ingots also showed a reduction of about £2 per ton.

### Quotations.

Pig iron: Lincolnshire, No. 3 foundry, 56s. 6d.; Staffordshire, 56s. 6d.; Derbyshire, 57s. to 57s. 6d.; Northamptonshire, 57s. 6d.; Middlesbrough, open brands, 60s. to 60s. 8d. Scotch (nominal): Gartsherrie, 68s. to 68s. 6d.; Glengarnock, 65s. 6d.; Eglinton, 64s.; Summerlee, 66s., delivered Manchester. West Coast hematite, 64s. 6d. to 65s.; East Coast ditto, 62s., both f.o.t. Delivered Heysham: Gartsherrie, 66s. to 66s. 6d.; Glengarnock, 63s. 6d.; Eglinton, 62s.; Summerlee, 64s. Delivered Preston: Gartsherrie, 67s. to 67s. 6d.; Glengarnock, 64s. 6d.; Eglinton, 63s.; Summerlee, 65s. Finished iron: Bars, £7 5s.; hoops, £7 12s. 6d. to £7 15s.; sheets, £8 7s. 6d. Steel: Bars, £6 7s. 6d. to £6 12s. 6d.; Lancashire hoops, £7 7s. 6d.; Staffordshire ditto, £7 17s. 6d. to £8; sheets, £9 to £9 5s.; boiler plates, £7 5s.; plates for tank, girder and bridge work, £6 12s. 6d. to £6 15s.; English billets, £4 15s. to £4 17s. 6d.; foreign ditto, £4 5s. to £4 7s. 6d.; cold drawn steel, £9 10s. to £9 15s. Copper: Sheets, strips, &c., £78 per ton; small lots, 10d. per lb.; rods, £77 per ton; small lots 10d. per lb.; tough ingots, £68 15s.; best selected, £68 15s. to £69 5s. per ton. Copper tubes, 9½d.; solid drawn brass tubes, 7½d.; brazed brass tubes, 9½d.; condenser tubes, 8½d.; condenser plates, 7½d.; rolled brass, 7½d.; brass turning rods, 6½d.; brass wire, 7½d.; yellow metal, 7½d. to 7½d. per lb. Sheet lead, £22 10s. per ton. English tin ingots £147 per ton.

### The Lancashire Coal Trade.

Business practically at a standstill, with no change in any department.

### "Steaming" in Weaving Sheds.

IN order to see for himself the actual conditions which prevail and the various means adopted to provide the necessary degree of moisture in the atmosphere for weaving successfully, the Home Secretary, Mr. McKenna, last week paid visits to several factories in Lancashire. He visited premises selected respectively by the employers, the factory inspectors, and the operatives, and was accompanied by three official advisers, namely, Sir Arthur Whitelegge, Chief Inspector of Factories; Mr. J. Jackson, Superintendent Inspector for Manchester; Mr. Delevigne, the Assistant Under-Secretary at the Home-office. In the different sheds Mr. McKenna was shown several of the most used principles of humidification, including the Vortex, in which the moisture is diffused into the atmosphere in the form of finely atomised sprays of water; the Hargreaves humidifier, in which an atomised water spray is blown on to the warp; and the old-fashioned "steaming" method. He also had an opportunity of investigating the much-debated question of "fining," and heard the views of both the employers and operatives on the subject.

### Thomas Newbigging.

Mr. THOMAS Newbigging, whose death occurred on Tuesday last at Knutsford, at the age of eighty-one, was a pioneer in the gasmaking industry. He came from Scotland to Lancashire at the age of eleven, and when he was twenty-four years old was made manager of a local gas company in the Rossendale district, an appointment he held for thirteen years. In 1870 he went to Brazil to manage the gasworks at Pernambuco, where he stayed for five years. In 1875 he returned to Manchester and commenced what ultimately proved a very successful practice in consulting and civil engineering. In gas engineering Mr. Newbigging was regarded as one of the leading authorities, and his services were much sought after as an expert witness before Parliamentary Committees. He was one of the founders of the British Institution of Gas Engineers and a member of the Institution of Civil Engineers. Mr. Newbigging's three sons are all engaged in the gasmaking industry, one son, Mr. J. G. Newbigging, being the gas engineer to the Manchester Corporation.

### Lancashire Holidays.

All trades in this district are more or less affected by the Whitsuntide holidays, which extend over practically the whole week. Some engineering works closed down last Saturday till next Monday, while others suspended work on Thursday last for the remainder of the week. The attendance on 'Change on Tuesday was very thin, and there was little or nothing in the way of business transacted. Most engineering establishments in the Manchester district have still plenty of work on hand, and if the prospect of a continuance of busy times is not as good as it has been, there is no sign of an immediate slump.

BARROW-IN-FURNESS, Thursday.

### Hematites.

There is no change to note in the general condition of the hematite pig iron trade. The output of metal is very considerable, and for the current week the consumption is not so heavy on account of the fact that many steel makers are observing the holidays. However, with next week the whole of the users of iron will again have full requirements and the iron will be going into prompt use. Prices are unchanged, with makers quoting 66s. to 67s. per ton net f.o.b. for parcels of mixed numbers of Bessemer iron. Special brands of iron are quoted at 72s. to 74s. per ton. Warrants are idle at 61s. per ton. The demand for iron is fairly good, but the business done this week is small, as is always the case during the holiday period.

### Iron Ore.

The demand for hematite iron ore is strong for the most part, although in some parts of the district there has been a little easing down of the local demand. On general account the inquiry is well maintained. Prices are much the same, with good average sorts quoted at 13s. 6d. to 15s. 6d. per ton net at mines, and the best qualities are at 20s. 6d. per ton. For Spanish ores there is a steady demand. A cargo of over 4000 tons was landed at Barrow last week from Benisaf. This ore is quoted at 16s. to 17s. per ton delivered.

### Steel.

The holidays are being observed in the steel trade, but next week will see a renewal of the activity in most of the departments. Good orders are held for rails and ship-plates. The demand for rails is fairly active, with heavy sections at £5 18s. 6d. to £6 2s. 6d. per ton. Light rails are at £6 7s. 6d. per ton and represent a quiet business, and not much is on offer in heavy tramway rails, which are quoted at £6 7s. 6d. per ton. There is a steady inquiry for steel shipbuilding material and the current rate is £6 10s. to £6 15s. per ton, and boiler plates are quoted at £7 10s. to £7 15s. per ton. For hoops there is a steady request at £8 5s. per ton. Nothing is yet being done in tin bars or steel billets.

### Shipbuilding and Engineering.

These trades are well employed in every department, and for Whit-week only one day's holiday was the order. The fitting out of the Turkish battleship Roshedieh is proceeding, but there is still much to do on her before she can leave for her trials. The British battleship Emperor of India is not so far advanced, but still a lot of work has been done on her, and her machinery is in position and the deck work is being pushed along.

### Fuel.

There is a good steady demand for coal, and steam sorts are at 15s. 6d. to 17s. 6d. per ton. East Coast coke is in full demand at 19s. to 21s. per ton delivered, Welsh coke at 20s., and Lancashire sorts at 18s. per ton delivered.

## THE SHEFFIELD DISTRICT.

*(From our own Correspondent.)*

### A Holiday Week.

THE holiday spirit has prevailed over almost every other consideration this week, and there is little or nothing of business to report. The whole of the Sheffield district, for the greater portion of the week, gave itself up to the various Whitsuntide attractions and practically no serious work will be resumed until Monday in most cases. Many works arranged to close for the whole week. In some instances this was undoubtedly due to a need for overhauling machinery and engines, as well as for stocktaking; but the fact cannot be overlooked that there are firms with order books so depleted that a week's stoppage was rather acceptable. It is from such sources that one gains the impression that trade is suffering from a bad break; but just as often there come to one's knowledge reports of other firms

being very well employed indeed. I have frequently drawn attention to the activity of the armament firms, yet there, again, exceptions are to be found, though not to anything like so pronounced a degree as on the industrial side. Nevertheless, from what can be gathered, the output of armour plate and ship forgings and castings for April was not anything like that for the preceding month or for the corresponding month of 1913. It may be that finished tonnage is accumulating, but whether or not the immediate effect is to add to the general uncertainty of the situation. Steel firms with a wide range of manufactures are faring best just now, especially where the highest class work is catered for, and the fact that really important extensions are still being pushed on with by several firms gives the outlook for trade a rather brighter appearance. Works connected in any way with shipbuilding, engineering, and motor building are easily holding their own. Orders involving railway, tramway, colliery, and Government stores continue to come forward fairly well, and some good contracts are in hand for the Argentine railways and tramways, as well as similar work for Russia. One hopeful feature is that unemployment is officially stated to be keeping at the minimum, although reports of moulders being suspended at various works keep coming to hand. These men, however, it is usually found, are engaged in the old departments, the more modern remaining in moderate activity. One firm in this district has contracted to supply a heavy quantity of tramway tires to the West Ham Tramways. Another is to make points and crossings for South America. Good orders for steel have been placed here from New York and Montreal, and on South African account a firm has secured a fairly large contract for steel.

**Pig Iron, Bars, and Billets.**

There is, of course, simply nothing being done this week in the pig iron market. Quite apart from the fact of the holidays, consumers had dropped out, except for small open market sales, and with the excuse of the Whitsun break even that feeble movement has been temporarily suspended. Underselling is reported to have induced a weakness in some directions, though, generally speaking, makers maintain a firm attitude as to price. Under the circumstances, Lincolnshire basic iron is finding few buyers at even a shilling or so below the official price of about 55s. Foundry and forge are stagnant. Derbyshire foundry is offered at about 54s., but has been done at less, and forge is scarcely moving at about 50s. West Coast hematite is little better at about 73s. for ordinary makes delivered Sheffield, but special qualities are in fair demand. East Coast mixed numbers are practically unchanged, but with a somewhat easy tendency. Crown bars are not showing any appreciable improvement at £7 5s., and billets are still dull under continental competition, and in sympathy with other sections the demand is at the moment quite nominal. The quotations are generally about as follows, though business might probably be done at less :—Siemens acid, £6 15s. to £7 ; Bessemer acid, £6 10s. to £6 15s.; hard basic, £5 10s.; soft, £4 15s.; foreign soft, 84s. to 86s. Scrap is listless.

**Fuel.**

The collieries have been closed down most of the week, but owing to the general holiday there has naturally been no demand for supplies. There was already, in fact, a falling off in industrial consumption, and so far this season shipments have by no means come up to the average. On the other hand, with the new pits getting into swing and the discovery of the Barnsley seam at a new sinking in the Mexborough district, the output is constantly increasing, and these influences are combining to weaken the market for steams. Collieries are more inclined to meet buyers, but the latter are holding off so far as forward business is concerned, very few being tempted by fractional reductions. Best South Yorkshire hards are 11s. to 11s. 3d.; best Derbyshire, 10s. 3d. to 10s. 9d. Slacks lack strength and blast furnace coke continues a poor market at about 10s.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

**Cleveland Iron Trade.**

An event which will be marked down in the history of the Cleveland iron trade occurred during the Whitsun holidays, when Cochrane and Co., Limited, blew out their No. 2 furnace at the Ormesby Ironworks for the purpose of re-lining. The furnace has been in blast just over thirty-eight years, having been first put into operation on May 8th, 1876. This, it is believed, constitutes a record of life for a blast furnace lining, not only in the Cleveland district, but in the world. During the time it has been in blast the furnace has produced 1,365,387 tons of Cleveland iron. The "shell" is capable of taking a 45,000 cubic feet furnace, which makes it easily the largest furnace in existence. The firm has put another furnace in operation. There has, of course, been very little business transacted on the Cleveland market this week. The Whitsun holiday was ostensibly the cause of this, but as a matter of fact lack of buying, except of a hand-to-mouth description, has become quite a normal state of affairs. Notwithstanding the dulness of trade, a steady tone prevails in the market, and there is no disposition on the part of makers to give way. The iron made is steadily going into consumption, and, having sufficient orders in hand, makers are content to go quietly on and await the revival which must come with the autumn buying. The general market quotation for No. 3 G.M.B. Cleveland pig iron is 51s. 6d., while No. 1 is 54s.; No. 4 foundry, 51s. 3d.; No. 4 forge, 50s. 9d.; and mottled and white iron, each 50s. 3d., all for either early or forward delivery.

**Hematite Pig Iron.**

There is a quiet tone to note in the hematite pig iron market for East Coast brands, and the amount of new business coming to hand does not represent a large tonnage of metal. There is no disposition on the part of consumers to place orders except for immediate requirements. In consequence of the holidays most of the furnaces have been run on short blast this week. The trade is feeling the effects of the slackness in finished iron and steel. The sellers' quotation for East Coast mixed numbers is still 61s. for either early or forward delivery.

**Iron-making Materials.**

The foreign ore trade remains dull, consumers in many cases holding back in the belief that values will be reduced in the near future. Sellers still quote on the basis of 17s. 6d. for best Bilbao Rubio of 50 per cent. quality ex ship Tees, but substantial business would no doubt induce reasonable concessions. Coke remains steady around 17s. 3d. for good medium furnace kinds delivered at the works. The price is held to be too high, but makers declare that it does not pay to make coke at the present figure while the coal can be so profitably disposed of.

**Manufactured Iron and Steel.**

In the manufactured iron and steel trades the outlook is dull, but specifications are coming in fairly well, and most producers have sufficient business to keep them going for some little time ahead. All the mills on the North-East Coast were closed down on Saturday last over the Whitsun holidays, and in the meantime ironmasters took advantage of the opportunity to effect repairs and alterations. Work was resumed on Wednesday with one or two exceptions. There are a good few orders to come out, but buyers appear to be holding off for easier terms. On the other hand, producers cannot see their way to reductions with the present costs of production so high, and prefer to mark time. The London building trade dispute is handicapping the trade in steel joists and sections. The following are the principal market quotations :—Common iron bars, £7 ; best bars, £7 7s. 6d.; best best bars, £7 15s.; packing iron, £6 5s.; iron ship angles, £7 ; iron engineering angles, £7 ; iron ship plates, £6 15s.; iron girder plates, £7 5s.; iron ship and girder rivets, £7 5s.; steel bars, basic, £6 5s.; steel bars, Siemens, £6 15s.; steel ship angles, £6 2s. 6d. to £6 7s. 6d.; steel engineering angles, £6 17s. 6d. to £7 ; steel sheets, singles, £8 5s.; steel sheets, doubles, £8 10s.; steel joists, £6 12s. 6d.; steel hoops, £6 10s.; steel strip, £6 5s., all less the usual 2½ per cent. f.o.t. Heavy steel rails, £6 ; steel railway sleepers, £7 5s.; light iron rails, £7, all net at works. Cast iron chairs, £4 5s.; cast iron pipes, 1½in. to 2in., £6 7s. 6d.; 3in. to 4in., £6 ; 5in. to 8in., £5 15s.; 10in. to 16in., £5 17s. 6d.; 18in. to 24in., £5 17s. 6d.; cast iron columns, plain, £7 7s. 6d.; floor plates, £3 10s. to £3 12s. 6d., f.o.r. at makers' works. The demand for galvanised sheets continues on the quiet side, and some producers are reported to be short of work. The general quotation for sheets of 24 gauge is £11 5s. per ton, less the usual 4 per cent.

**Shipbuilding and Engineering.**

During the present week the vast industrial population on the North-East Coast gives itself up almost entirely to recreation. Hence most of the shipbuilding yards and engineering works were closed down until Wednesday. The shipbuilding trade is in a very healthy condition. Builders have an abundance of work on their books and contracts for new vessels continue to be placed. Short Brothers, of Sunderland, have received an order for a large collier with a deadweight capacity of 11,500 tons and a length of 450ft., and a contract for a similar vessel has been placed with William Doxford and Sons, while Sir Raylton Dixon and Co., Middlesbrough, are to build a new passenger vessel for the Langlands Coasting Line. The engineering trades are well engaged both on home and foreign account.

**Ironworkers' Wages Reduced.**

The slump in prices of manufactured iron is reflected in the report for the past two months issued by the secretaries to the Board of Conciliation and Arbitration for the manufactured iron and steel trade of the North of England. The production for the two months is put at 9077 tons and of the average net selling price of bars, plates, angles, and rails at £6 14s. 9d., as against £6 18s. 9d. for the previous two months, a drop of no less than 4s. per ton. It is satisfactory to note, however, that the sales showed an increase of 263 tons over the preceding two months. Ironworkers' wages will be reduced by 3d. per ton on puddling, and 2½ per cent. on all other forge and mill wages, to take effect from the 1st inst.

**Coal and Coke.**

Business in the coal trade has been restricted, chiefly owing to the holiday influence. So far as prompt business is concerned, collieries are very fully sold, and hold for late values. For the second half of June the prospects are fairly bright, and with tonnage supplies keeping plentiful sellers show no inclination to make concessions. Best qualities of Durham gas coals are quoted about 13s. 3d. per ton f.o.b., and seconds at 12s. 3d. A fair demand for bunker coals is reported and values are firm. Best qualities command 12s. 9d. to 13s. and ordinaries 11s. 6d. to 12s. There is a little more coking unscreened coal on the market, but the quotation remains at 12s. to 12s. 6d. and smalls at 12s. For coke there is a full request and prices are firm. Foundry coke is 19s. to 21s.; furnace coke, 17s. 3d. to 17s. 6d.; and gas coke, 13s. to 13s. 9d.

## NOTES FROM SCOTLAND.

*(From our own Correspondent.)*

**Pig Iron.**

There are seventy-two furnaces in blast in Scotland, compared with seventy-one in the preceding week and eighty-seven in the corresponding week of last year. Makers are finding no difficulty in disposing of their production of ordinary qualities and hematite and stocks in makers' yards are not increasing to any extent. The import of pig iron into Grangemouth from Middlesbrough and district reached the total of 10,491 tons for the week.

**Quotations.**

The prices of makers' iron are unchanged, and are as follows :—Monkland is quoted f.a.s. at Glasgow, No. 1, 62s.; No. 3, 60s. 6d.; Govan, No. 1, 61s.; No. 3, 60s.; Carnbroe, No. 1, 66s. 6d.; No. 3, 62s. 6d.; Clyde, No. 1, 68s.; No. 3, 63s.; Gartsherrie, Summerlee, Calder and Langloan. No. 1, 68s. 6d.; Nos. 3, 63s. 6d.; Glengarnock, at Ardrossan, No. 1, 71s.; No. 3, 66s.; Eglinton, at Ardrossan or Troon, No. 1, 62s.; No. 3, 61s.; Dalmellington, at Ayr, No. 1, 63s.; No. 3, 61s.; Shotts, at Leith, No. 1, 68s. 6d.; No. 3, 63s. 6d.; Carron, at Grangemouth, No. 1, 69s.; No. 3, 64s. per ton.

**The Warrant Market.**

The principal feature of the Glasgow pig iron warrant market during the week has been the heavy withdrawals from warrant stores, amounting in all to 5461 tons, and reducing the total amount in store to 82,052 tons, and this has had a hardening effect on prices. Cleveland iron closed at 51s. 4½d., showing a gain of 2½d. per ton on the week. The trade position has not improved to any extent, and business with consumers continues on a hand-to-mouth basis.

**Finished Steel.**

There is no change to report in the position of the steel trade generally. Makers still complain of a lack of specifications for plates, and it is with great difficulty that mills are kept running. Sectional makers are also in need of an increase in business. The home demand is quiet and sales are for the most part of small quantity. Some buyers are willing to contract ahead at the current prices, but makers cannot see their way to book such orders, owing to small margin of profits. The export demand shows no sign of immediate expansion.

**Finished Iron.**

The general position of the manufacturing branches of the iron trade leaves little room for encouragement. Black sheet makers are having to struggle hard to keep their plants occupied, but despite the hand-to-mouth nature of the demand outputs are fairly satisfactory. In some cases makers are accepting contracts over the year at the current rates, but others are not inclined to commit themselves, owing to the low level of quotations. The malleable iron trade continues in a very disappointing position. Foreigners are quoting very low prices for competitive material, and large quantities of hoops, bars and strips are still being imported from the Continent. The works are greatly in need of more orders, but there seems little hope of an improvement so long as foreign competition continues so keen. Makers still quote £6 12s. 6d. per ton, less 5 per cent., for "Crown" bars for Glasgow delivery, and about £6 per ton net f.o.b. Glasgow.

**Wages in the Iron Trade.**

In view of the prices which have been obtained for iron products within the last three months wages will be reduced by 2½ per cent.

**The Coal Trade.**

Business on the whole shows little change from the preceding week. In the western district the outstanding feature is the demand for splint coal, and collieries are full up with orders for this class. Other classes are, with the exception of navigation qualities, weaker, and prices show a declining tendency. In the Lothians district the collieries are well employed, and coalmasters are viewing the future with more confidence, while in the Fifeshire district business is satisfactory without being out of the common, with navigation coals the chief feature. The aggregate shipments from Scottish ports during the week amounted to 318,872 tons, compared with 345,644 tons in the preceding week and 343,658 tons in the corresponding week of last year. Ell coal is quoted f.o.b. at Glasgow 11s. to 11s. 3d.; splint, 10s. 9d. to 14s.; navigations, 14s. 6d. to 14s. 9d.; steams, 10s. 9d. to 12s. 9d.; treble nuts, 11s. 6d. to 11s. 9d.; doubles, 10s. 6d. to 10s. 9d.; and singles, 10s. 3d. to 10s. 6d. per ton.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

**Cardiff Coal Market.**

There has been no change nominally in values owing to the holidays, and business has scarcely yet been resumed. At the end of last week there was something in the nature of a spurt in prices, the fear that outputs would be so substantially curtailed owing to leave-taking, resulting in colliery salesmen advancing their quotations 6d. to 1s. per ton for June loading, but there was very little demand. It is unlikely that much in the way of business will be done for some days, and so far at the time of writing it is impossible to test values. Colliery salesmen are holding out for high figures in some cases, but the majority prefer to wait until they can see their position clearly before definitely making any quotations. The official holidays in the coalfield covered Monday, Tuesday and Wednesday, but it is probable that large numbers of men will be absent from work throughout the whole week, which, of course, will result in a material reduction in output. There was no shipment of coal at Cardiff, Penarth and Barry Docks on Monday and Tuesday, the trimmers having decided to take a day off on the Tuesday as well as on the Monday. The tonnage in dock is much below the normal quantity, although sufficient for immediate requirements. Unless there is a considerable improvement before the end of the week, it is probable that some of the collieries will be placed in an awkward position, and will be compelled to accept lower figures than those indicated for spot shipment in order to secure empty wagons.

**Nominal Values.**

Steam coal : Best Admiralty large, 20s. to 20s. 6d.; best seconds, 18s. 9d. to 19s. 3d.; seconds, 17s. 9d. to 18s. 3d.; ordinaries, 17s. 3d. to 17s. 9d.; best drys, 18s. 3d. to 18s. 6d.; ordinary drys, 16s. to 16s. 9d.; best bunker smalls, 11s. to 11s. 3d.; best ordinaries, 10s. 3d. to 10s. 6d.; cargo smalls, 7s. 9d. to 8s. 6d.; inferiors, 7s. to 7s. 6d.; washed smalls, 12s. to 12s. 6d.; best Monmouthshire black vein, large, 17s. 3d. to 17s. 6d.; ordinary Western Valleys, 16s. 6d. to 16s. 9d.; best Eastern Valleys, 15s. 6d. to 16s.; seconds Eastern Valleys, 15s. to 15s. 3d. Bituminous coal : Best households, 19s. to 20s.; good households, 17s. to 19s.; No. 3 Rhondda large, 17s. 6d. to 18s.; smalls, 12s. to 12s. 6d.; No. 2 Rhondda large, 13s. to 13s. 6d.; through, 11s. 6d. to 12s. 6d.; smalls, 9s. to 9s. 6d.; best washed nuts, 16s. to 16s. 6d.; seconds, 14s. 6d. to 15s. 3d.; best washed peas, 14s. 6d. to 15s.; seconds, 13s. to 13s. 6d. Patent fuel, 19s. to 21s. 6d. Coke : Special foundry, 28s. to 29s.; good foundry, 22s. to 25s.; furnace, 17s. to 19s. Pitwood, ex ship, 21s. to 21s. 6d.

**Newport (Mon.).**

The market continues to be under holiday influences, and is likely to be so affected this week. The tone is firm, but owing to the unsettled conditions it is difficult to give values with any certainty. Colliery salesmen report good order books for June, and indicate rather higher figures, if anything, than those nominally in force. Approximate prices :—Steam coal : Best Newport black vein, large, 17s. to 17s. 6d.; Western Valleys, 16s. 6d. to 17s.; Eastern Valleys, 16s. to 16s. 3d.; other sorts, 15s. 3d. to 15s. 6d.; best smalls, 8s. 3d. to 8s. 9d.; seconds, 7s. 9d. to 8s. 3d. Bituminous coal : Best house, 18s. to 19s.; seconds, 17s. to 18s. Patent fuel, 19s. 6d. to 20s. 6d. Pitwood, ex ship, 21s. 3d. to 21s. 6d.

**Swansea.**

There has been no activity on the Swansea Exchange during the past few days owing to the Whitsun vacation. Offices have been opened, but more to enable attention to be given to correspondence. Some days must elapse before business is resumed with any seriousness. Meanwhile, there is very little change in prices from those ruling before the holidays. Nominal quotations :—Anthracite : Best malting, large, 21s. 6d. to 23s. net ; second malting, large, 17s. 9d. to 19s. net ; big vein, large, 15s. 9d. to 16s. 9d., less 2½ per cent.; red vein, large, 12s. 9d. to 13s. 6d., less 2½ per cent.; machine-made cobbles, 21s. to 22s. net ; French nuts, 21s. 9d. to 23s. 9d. net ; German nuts, 21s. 9d. to 23s. 6d. net ; beans, 15s. 9d. to 17s. 3d. net ; machine-made large peas, 11s. to 12s. net ; rubbly culm, 6s. 3d. to 6s. 9d., less 2½ per cent.; duff, 4s. 6d. to 4s. 9d. net. Steam coal : Best large, 18s. 9d. to 20s. 9d., less 2½ per cent.; seconds, 14s. 6d. to 15s. 6d., less 2½ per cent.; bunkers, 11s. to 12s., less 2½ per cent.; smalls, 8s. 3d. to 9s. 3d., less 2½ per cent. Bituminous coal : No. 3 Rhondda, large, 17s. to 18s., less 2½ per cent.; through and through, 14s. 6d. to 15s., less 2½ per cent.; smalls, 11s. to 11s. 9d., less 2½ per cent. Patent fuel, 17s. to 17s. 6d., less 2½ per cent.

**Tin-plate and Other Quotations.**

I.C., 20 × 14 × 112 sheets, 12s. 6d.; I.C., 28 × 20 × 56 sheets, 12s. 9d.; I.C., 28 × 20 × 112 sheets, 25s.; I.C. terne, 28 × 20 × 112 sheets, 22s. to 22s. 6d.; finished black plates, £9 10s. per ton ; galvanised sheets, 24 g., £10 15s. to £11 per ton. Block tin, £140 per ton cash, £142 per ton three months. Copper, £62 7s. 6d. per ton cash, £63 per ton three months. Lead : English, £19 10s. per ton ; Spanish, £19 5s. per ton. Spelter, £21 10s. per ton. Silver, 26d. per oz.

**Iron and Steel Trades.**

Pig iron : Standard iron, 51s. 7½d. cash, 51s. 9d. month ; hematite mixed numbers, 61s. cash, 61s. 1½d. month ; Middlesbrough, 51s. 6d. cash, 51s. 7½d. month ; Scotch, 57s. 6d. cash, 57s. 7½d. month ; Welsh hematite, 65s. dd.; East Coast hematite, 64s. c.i.f.; West Coast hematite, 66s. to 67s. c.i.f. Steel bars : Siemens, £4 11s. 3d. per ton ; Bessemer, £4 10s. per ton. Steel rails, heavy sections, £6 2s. 6d. Iron ore : Rubio, 17s. to 17s. 6d

CONTRACTS.—Perman and Co., Limited, of 82–83, Fenchurch-street, E.C., have received a contract from a firm of shipowners in London for a pair of Kromhout engines to drive twin screws, each engine to develop 275 brake horse-power at about 225 revolutions per minute. The engines will each have four cylinders, and will be of the latest hot bulb type.

## NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

*(From our own Correspondent.)*

### Rheinland-Westphalia.

BUSINESS still moves on slowly in the raw and finished iron industries. The market is unsettled, quotations varying a good deal, but in all departments unremunerative prices are complained of. Bars for delivery in the third quarter of this year are reported to have been offered by several Rhenish-Westphalian mills at M.92 to M.93 p.t. Still, both consumers and dealers show the utmost reserve, especially the latter, who are evidently awaiting the development of the market, or rather a further decrease in quotations. A languid trade is being done in sectional iron, although demand and employment in May showed a slight improvement compared with April. The lack of enterprising spirit in the building department continues; a falling off in demand and prices for pipes can be noticed, and for gas pipes the larger mills are now granting an extra rebate of 3 per cent. At a meeting of the Steel Convention on May 27th, it was resolved to maintain present prices during the third quarter, both for semi-finished steel and sectional iron. On foreign account only a moderate business is reported.

### The Silesian Iron Market.

All through this and the last month a quiet sort of business has been done in the different sorts of iron and steel; keen competition from the West of Germany has been the cause of a downward tendency in quotations, and the outlook seems anything but bright. At the bar mills activity is supported to a moderate degree only, and the plate department also lacks strength, the demand in medium and thin sorts being particularly dull. Exports of late have been hardly worth mentioning. The coal trade in Silesia, as well as in Rheinland-Westphalia, has remained tolerably brisk, and rates are firm.

### Austria-Hungary.

All the works, and especially those engaged in the finished iron and steel industries, continue to be insufficiently employed. Prices are only nominal, for producers naturally agree to reductions most willingly if an order of some weight is in question. These, however, are scarce, and the lack of enterprising spirit is very marked. Pit and brown coal sell regularly.

### No Change in Belgium.

Business in the iron and steel industry has continued on much the same lines as in the preceding week. Very little is done on the home market. Both orders and specifications are insufficient in the raw and finished iron department, while sales of crude iron have been limited to the most urgent requirements, and though prices until now have been tolerably well maintained, they are sure to meet with a reduction before long. The position, certainly, is anything but encouraging. There is not the slightest inclination among buyers to book ahead, and the various mills and factories can only just be kept going. Semi-finished steel is sold at 70s. f.o.b. Antwerp; heavy plates realise £4 13s. p.t., while the ¾in. sorts stand at £4 16s. p.t. Quotations for bars are yielding no profit; basic bars can be obtained at £4 2s. p.t. The precarious state of the iron business cannot fail to influence the coal market in Belgium. The consumption of engine coal has strongly decreased, and the business in briquettes is likely to be rather below the average during the present quarter. Offers are plentiful in the coke trade. A reduction that was intended for July 1st this year seems hardly necessary, because producers willingly agree to almost any reduction in price rather than lose an order.

## AMERICAN NOTES.

*(From our own Correspondent.)*

NEW YORK, May 22nd.

BIDS will be opened on Saturday for 3000 tons of steel for the approaches to the East River tunnel. The tunnels themselves call for 90,000 tons of cast iron segments which will not be ordered for some time. Fabricating shops booked orders for 23,000 tons for steel buildings, bridges and manufacturing plants. The municipal pier at Chicago calls for 6000 tons. Car orders for week, 4204. Small structural orders foot up very well. The Astor Apartments take 2500 tons. The New York Central, 1900 tons for bridge work. The Brooklyn–Catskill water pipe line will take 3000 tons of plates. Bids have been received for 8000 tons of Government work. The bridge steel-making plants can now run for a while to 80 per cent. of capacity. The belief is growing that better conditions are close at hand. Railway buying continues quite scattered. An enormous amount of business is pigeon-holed, and it is this fact that gives so much confidence in recuperative tendencies. The inquiries for pig iron received this week are very encouraging, reaching in some cases 10,000-ton lots for third and fourth quarter delivery. Users of crude iron have very little stock outside of cast iron pipe makers. The pending business for basic pig alone figure fully 50,000 tons, and will probably exceed those figures. The furnaces will probably feel the first benefit of improving demand. It is difficult to understand how consumers can much longer delay the placing of orders for delivery during the last half of the year. It is believed in certain business circles that Congress will postpone definite legislation on the anti-Trust laws until next winter. If so, business will improve. Under normal demand the industry of iron and steel would be working to 90 per cent. of capacity. Its average is 30 per cent. under. Copper exports since May 1st, 22,051 tons. Electrolytic is firm at 14¼, and a good week's business has been done. Exports since January 1st, 170,488 tons. The low domestic demand is the feature of the market. A buying movement is looked for very soon.

NEW YORK, May 27th.

The strongest feature in the steel market this week is the purchase by Eastern mills of 80,000 tons of basic pig for delivery during the last half of the year, while negotiations for several large blocks for similar delivery betoken improving activity. Large purchases have been made of low-grade iron for cast pipe. In view of the pending order for 80,000 tons of cast iron segments for the river tunnels, bids have been taken on 60,000 tons of pig, mostly No. 2 plain and No. 3 foundry, but these deliveries will extend over two years. Foundries are running from 50 to 60 per cent. of capacity. Sentiment in steel is improving. Railroad buying is somewhat better, but only urgent needs are covered. The week's orders were 8755 cars. Since May 1st, 12,924. Rail orders, 12,100 tons. For oil tanks, 9000 tons were ordered. The general view is that the present abnormal conditions cannot persist much longer. It would require a very brief period of normal activity to bring about a slight advance in prices, but the probabilities are that in many cases conditional contracts have been made under which buyers can escape any such advance if orders are placed within a given period. At some furnaces iron is being piled up to fill spot orders. With nearly all mills working one-third or more under capacity, it will be no difficult matter to take care of any demand that improved confidence may create. Electrical equipment plants are working far below capacity. Engineering plants are similarly situated. The promise of immense crops holds out high hopes. Calls are coming to Eastern labour to aid in crop harvesting, soon to begin. Exports of copper to date 26,838 tons; since January 1st, 179,073 tons; for first four months, 349,372,351 lb., an increase of 55,226,997 lb. over same time last year.

# BRITISH PATENT SPECIFICATIONS.

*When an invention is communicated from abroad the name and address of the Communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 8d. each.*

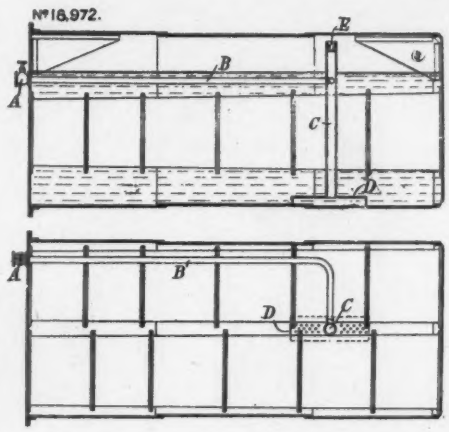
*The date first given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete Specification.*

*Any person may, on any of the grounds mentioned in the Act, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of any Patent.*

### STEAM GENERATORS.

18,972. August 21st, 1913.—FEED-WATER DISTRIBUTORS, W. H. Casmey, Woodthorpe Cottage, Milnthorpe, Wakefield, and another.

From the check valve A, a feed-water pipe B extends backwards, and bending round joins a vertical pipe C passing between

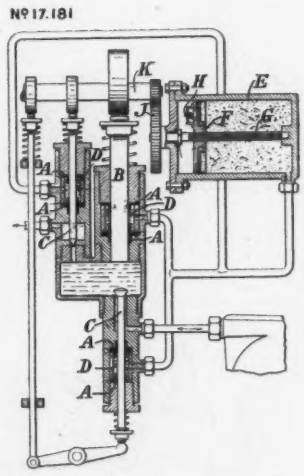



the furnace flues. The feed water flowing down this pipe reaches a distributing box D and escapes therefrom through the perforated top. A steam inlet nozzle is arranged at E, and it is claimed that the steam entering the pipe C at this point and meeting the cold feed water precipitates the salts and lime contained in the water.—*May 13th*, 1914.

### INTERNAL COMBUSTION ENGINES.

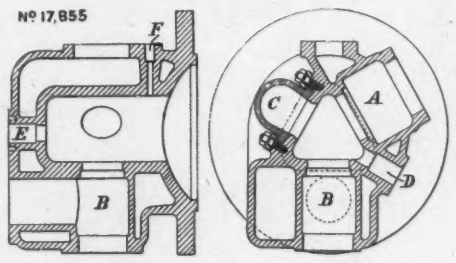
17,181. July 26th, 1913.—LIQUID FUEL PUMP, R. Esnault-Pelterie, 37, Rue des Abondances, Boulogne-sur-Seine, France.

This specification describes improved means of packing the glands of liquid fuel pumps. To prevent leakage past the




leathers A surrounding the piston B and valve stems C, C the spaces D are filled with a thick grease under pressure. The grease is fed into the spaces by the cylinder E, which contains a piston F working on a screwed shaft G and provided with safety valves H. The shaft G is rotated by gearing J from the cam shaft K.—*May 13th*, 1914.

17,855. August 5th, 1913.—COMBUSTION CHAMBERS FOR OIL ENGINES, E. Gardner, Barton Hall Engine Works, Patricroft, Lancs.

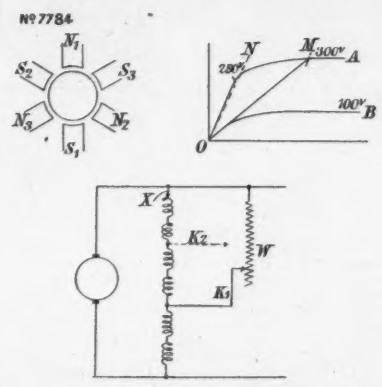



This combustion chamber is bolted to the end of the cylinder, and forms a cover therefor. It is triangular in cross-section, the faces being provided with extensions A, B, C. Extension A is for the air admission valve, B for the exhaust valve, while C forms the vaporising and igniting space. The body of the chamber and the extensions A, B are water-jacketed, but the extension C is not, so that external heat may be applied to it as required for starting. The oil spray is admitted at D, and the compressed air for starting purposes at E. F is an indicator seat.—*May 13th*, 1914.

### DYNAMOS AND MOTORS.

7784. April 2nd, 1913.—IMPROVEMENTS IN AND RELATING TO DYNAMO-ELECTRIC MACHINES, Allgemeine Elektricitäts-Gesellschaft, of Friedrich Karl-Ufer, 2-4, Berlin, N.W., Germany.

The upper left-hand drawing represents by way of example a six-pole self-excited shunt-wound machine with poles $N_1$, $N_2$, $N_3$, $S_1$, $S_2$, $S_3$. The normal voltage may be, for example, 300 volts, and the characteristic, with excitation of all six poles, is the curve A. The machine is stable at about 300 volts, corresponding to point M. If the resistance in the field circuit is increased for the purpose of regulation, in such manner that it runs nearly according to the line O N, then the voltage is unstable—say, at 250 volts. According to this invention, regulation is effected, for example, by short-circuiting, one or more pairs of poles. The curve B, for example, represents the characteristic with the excitation of only two poles, for example,

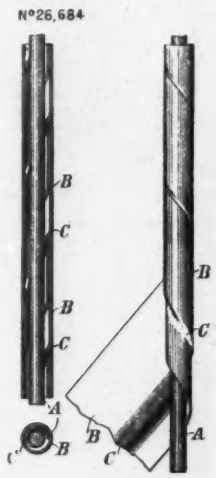



corresponding to a voltage of 100 volts. The poles are connected in series in pairs, each pair consisting of a north and a south pole, and preferably they are diametrically opposite each other. By the gradual short-circuiting of $N_1$, $S_1$, $N_2$, $S_2$, for example, by the resistance W any desired voltage is obtained between 300 and 100. At 100 volts the machine is completely saturated, since the only effective poles $N_3$, $S_3$ are fully excited, so that the poles $N_1$, $S_1$, $N_2$, $S_2$ may be entirely cut out, for example, by means of a switch X. The voltage may be further reduced by means of the resistance W, which may under some circumstances contain iron resistances. By the employment of the iron resistances, it is possible to regulate down to 20 to 30 volts. The more pairs of poles the machine possesses, the more the voltage may be reduced. Instead of simultaneously short-circuiting four poles, it is possible first to short-circuit only two poles, for example, by means of the contact $K_2$, indicated in dotted lines, and then the poles $N_2$, $S_2$ by means of the contact $K_1$. There are two other illustrations.—*May 13th*, 1914.

### TELEGRAPHS AND TELEPHONES.

26,684. November 20th, 1913.—IMPROVEMENTS IN INSULATED ELECTRIC CONDUCTORS, *Western Electric Company, Limited, of Norfolk House, Victoria Embankment, City of Westminster, W.C.*

This invention relates to improvements in insulated electric conductors and particularly to tape-wound conductors used in telephone cables. The principal feature of the invention is to obtain a cable of uniform capacity, in which the essential condition is that the conductors forming the cable be centrally



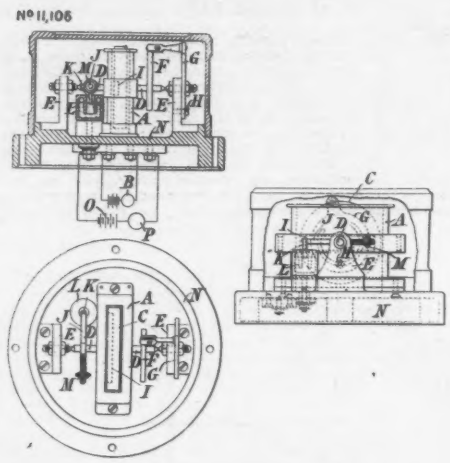

placed within the tape which envelops them. A is a conductor around which is spiraled an insulating tape B, preferably of paper having formed therein an inwardly extending ridge C, the inner margin of which engages the conductor A, thereby forming a support for the tape B and centring therein the conductor A. While the ridge, as illustrated in the drawing, has been shown as formed in the tape nearer one margin than the other, it is obvious that this invention in its broadest aspect is not limited to the ridge being formed in any particular portion of the tape, but may be formed in any portion thereof.—*May 13th*, 1914.

### WIRELESS TELEGRAPHY.

11,106. May 10th, 1913.—IMPROVEMENTS IN WIRELESS TELEGRAPHY, Marconi's Wireless Telegraph Company, Limited, and Cyril Percy Ryan, Commander R.N., all of Marconi House, Strand, London, W.C.

This invention relates to improved apparatus for giving alarms by means of wireless telegraphy when a series of signals which

have been transmitted at regular intervals of time, preferably by means of a pendulum or metronome, falls upon a detector. A is an electro-magnet which is energised when the relay B is actuated by the incoming signals. C is a balance wheel on an arbor D mounted in bearings on brackets E, and connected by a spiral spring F to a plate G, which can be clamped in any desired position on one of the brackets E by means of a screw H. Let into the wheel C is a strip of iron I. The arbor also carries an arm J, on one end of which is a contact finger K adapted, when the wheel comes into the position shown, to dip into mercury contained in a cup L, while the other end carries a




counterbalancing nut M. The arbor brackets and bedplate N are connected to a battery O and relay P, the other side of which is connected to the mercury in the cup L. Ordinary signals do not affect the balance wheel sufficiently to cause the finger K to dip into the mercury, and the relay P is therefore not actuated, but when a number of signals arrive at intervals equal to the period of oscillation of the balance wheel, this wheel is set swinging, and eventually the finger dips into the mercury, and the circuit through the battery O is closed and the relay P is actuated. This relay may consist of a trip contact which gives an alarm, and preferably also starts an electric motor, which resets the contact and may do other work.—*May 13th*, 1914.

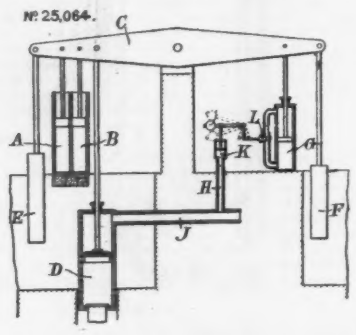
5535 March 4th, 1914.—IMPROVEMENTS IN OR RELATING TO WIRELESS TELEGRAPHY, Gotthelf Leimbach, Ph.D., of 15, Baurat Gerberstrasse, Göttingen, Germany.

The chief difficulty to be overcome when a bore-hole is formed in the earth for the reception of the antenna is that the antenna must be insulated from the subterranean water level in order to enable it to be brought to oscillate at all. This difficulty is met in accordance with this invention in a very simple manner by arranging a freezing tube, as employed in sinking shafts by the freezing process, in the bore-hole which is intended to receive the antenna. A small freezing machine forms a frozen cylinder around the freezing tube that protects from the surface down into the earth, which cylinder acts as a perfect insulator for electric oscillations, as has been established by experiments. In this way it is possible to allow the freezing tube to oscillate as the antenna, which is not possible with any other system. That part of the freezing tube which lies below the lower limiting surface of the underground water is the part that counts for the radiation. The advantages of a bore-hole will be obvious; the effective length of the antenna may be made several hundred metres if desired. The range is increased considerably by increasing the length of the antenna and by embedding the antenna in a medium having a higher dielectric constant—which constant, in the case of rock, for example, varies from 4 to 12.—*May 13th*, 1914.

## PUMPING AND BLOWING MACHINERY.

25,064. November 3rd, 1913.—PUMPING ENGINE, Henry Davey, Conaways, Ewell, Surrey.

This invention may be described as an internal combustion Cornish pumping engine. Two power cylinders A, B are arranged side by side and are connected to the beam C. D is the pumping cylinder, and its piston is also connected to the beam. The beam is suitably balanced by weights E, F. Just as in the Cornish steam pumping engine, the inertia of the moving parts enables the working fluid to be used expansively

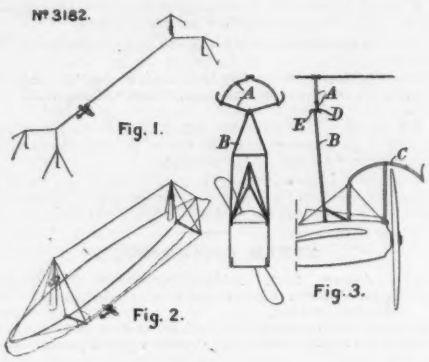



to overcome the constant pump resistance. To stop the engine when the load falls off a damping cylinder G is provided. A branch H is taken off from the discharge pipe J, and in this branch a weighted piston K works. This piston is connected by a lever with a plug L working in a passage joining the two ends of the cylinder. The pressure of the discharge keeps the plug out of action, but when this pressure falls the plug moves in and stops the free flow of liquid from one end of the damping cylinder to the other. Means for operating the exhaust valves of the gas cylinders and for obtaining a constant gas mixture are also described.—*May 13th*, 1914.

## AERONAUTICS.

3182. February 6th, 1914.—STARTING AND LANDING APPARATUS FOR AEROPLANES, L. Blériot, 56, Boulevard Maillot, Neuilly-sur-Seine, France.

Much has already been heard of this invention. It consists of a stretched wire mounted as shown in Fig. 1 when on land and as in Fig. 2 when on a ship, a bridle A running on this wire, and a double hook B carried on the aeroplane. C is a guard to pre-

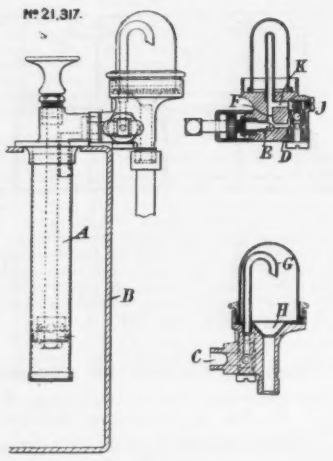



vent the propeller from striking the wire. The hook D is used for landing purposes and the hook E for starting.—*May 13th*, 1914.

## MISCELLANEOUS.

21,317. September 22nd, 1913.—LUBRICATOR, H. G. Atkinson, 107, Church-lane, Handsworth, Birmingham, and another.

This is a drip feed lubricator for combustion engines, and is normally operated by the pressure in the crank case. A force pump A is situated within an oil reservoir B and is arranged to deliver oil through the passage C into a chamber D in the



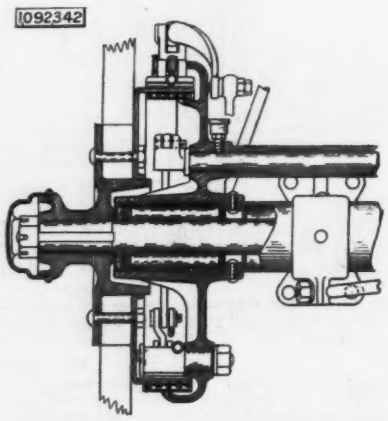

lubricator. Normally, however, the pressure in the crank case forces the oil past the valve E up the passage F and round the bend G into the orifice H. Should an extra supply of oil be required at any time the force pump is brought into action. Under such circumstances the quantity of extra oil supplied is not limited by the setting of the valve E for the ball valve J will now rise and will provide an additional passage K for the oil.—*May 13th*, 1914.

## SELECTED AMERICAN PATENTS.

*(From the United States Patent-office Official Gazette.)*

1,092,342.—VEHICLE BRAKE, *A. C. Culver and A. W. Russel, Detroit, Mich., assignors to Russel Motor Axle Company, Detroit, Mich., a Corporation of Michigan.—Filed August 30th*, 1913.

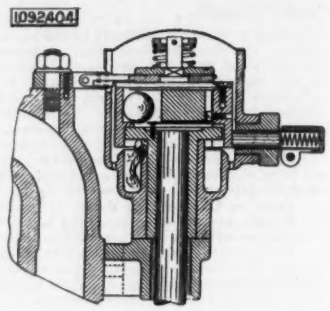
The inventor claims the combination with a brake drum, of




a brake head adjacent to it, having a laterally projecting flange with a circular edge portion concentric with the drum, and a brake strap interposed between the flange and drum and held by the former in concentric relation when in the released position. There are four claims.

1,092,404.—REVERSING DEVICE FOR COMBUSTION ENGINES, *W. Seck, Berlin-Wilmersdorf, Germany, assignor to the Firm of R. Bosch, Stuttgart, Germany.—Filed October 6th*, 1909.

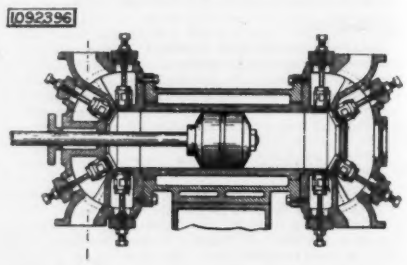
A circuit controlling contact is carried by the time shaft and a circuit controlling spring is electrically connected to it. This spring normally occupies an open circuit position. A movable member is normally out of engagement with the spring and is adapted when the speed of the engine passes below a predetermined value to move into engagement with the spring to cause the latter to occupy a circuit closing position. A rotatable circuit controlling member is electrically connected to the circuit controlling contact, and there are hand-operated means to move the circuit controlling member to cause it to break its circuit and automatically operated means for causing that member to




close its circuit when the direction of rotation of the timer shaft is reversed. There are five claims.

1,092,396.—AIR AND GAS COMPRESSOR, *M. Riesner, Cincinnati, Ohio, assignor to International Steam Pump Company, a Corporation of New Jersey.—Filed April 6th*, 1911.

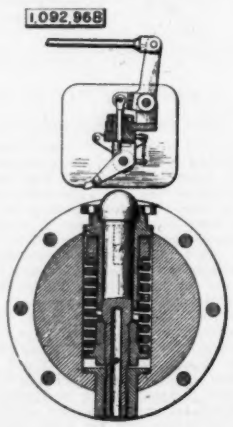
The pump cylinder has a cylinder head formed separately from and attached to the cylinder. This head is designed to provide suction and delivery chambers extending about the end of the




cylinder and it carries valves arranged in annular sets. One set of valves is arranged circumferentially about the end of the cylinder and the valves open radially to the cylinder, while the other set is arranged at the end of and opening in line with the cylinder. There are four claims.

1,092,968.—EMERGENCY GOVERNOR, *F. W. Bentley, Schenectady, N.Y., assignor to General Electric Company, a Corporation of New York.—Filed February 1st*, 1912.

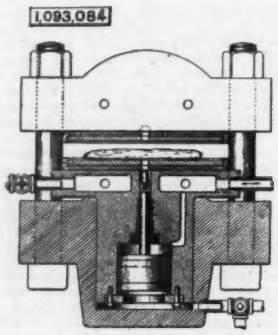
The governor has a rotary member having a diametrical recess in it. A centrifugally movable plunger is housed in this recess and is provided with a shoulder. A nut is in engagement with




the plunger, while a spring also encircles the plunger and abuts against the nut. A second nut encircles the plunger and a sleeve fits the plunger and is rotatable thereon, being in operative relation with the second nut for the purpose of adjusting the spring. Means are provided for retaining the sleeve in the recess. There are twelve claims.

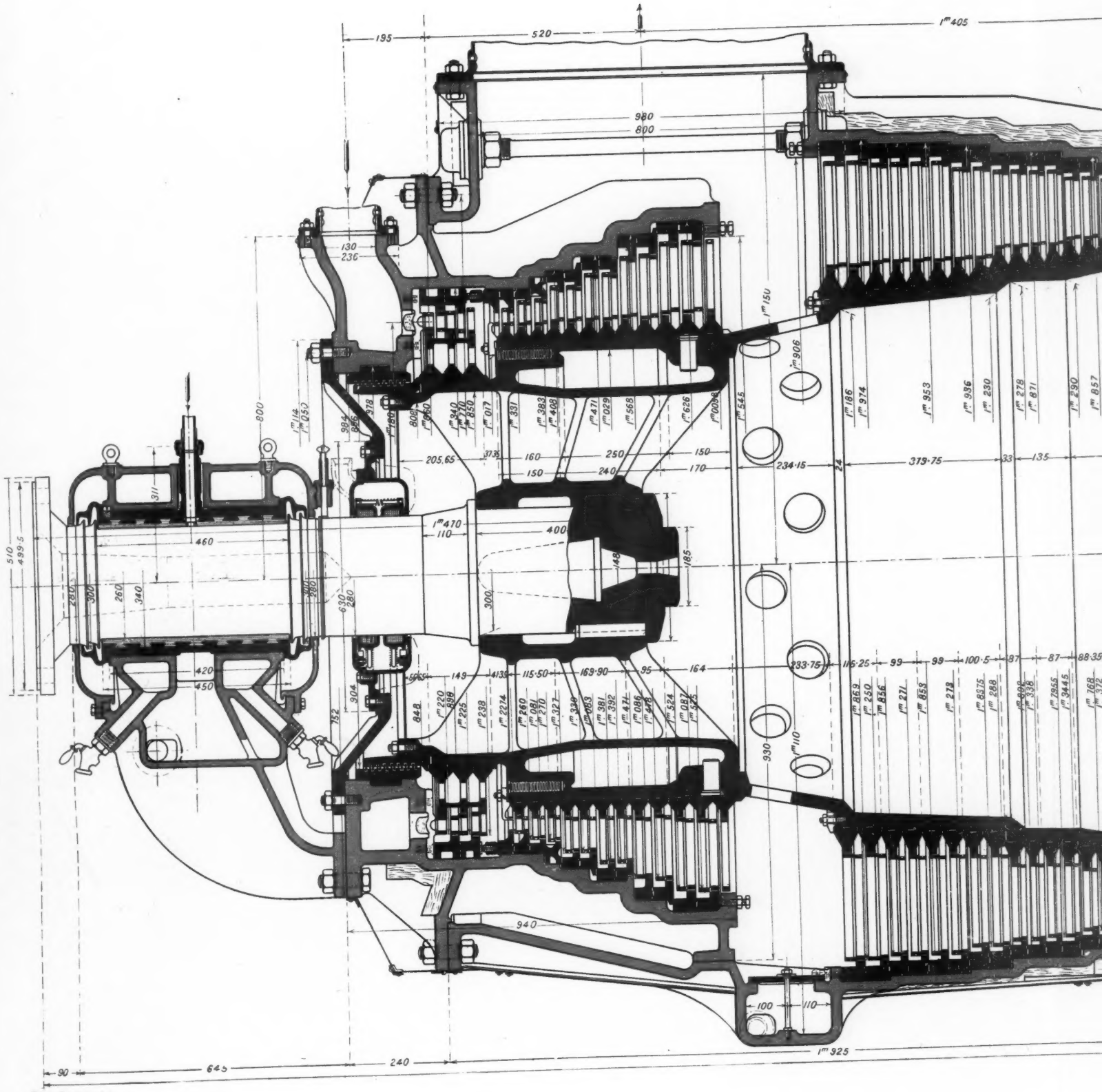
1,093,084.—HYDRAULIC PRESS, *T. Steventon, Bridgeport, Conn., assignor to American Graphophone Company, Bridgeport, Conn., a Corporation of West Virginia.—Filed October 11th*, 1912.

The press has a chambered bed-plate with a press ram fitted in the chamber and carrying a chambered platen at its upper end. There is a chamber in the lower part of the ram and a




restricted opening leading therefrom through the top of the platen and a passage connecting the upper end of the last-named chamber with the chamber in the platen. A piston and its plunger are fitted respectively in the last-named chamber and the opening, and there are means for admitting hydraulic pressure to the bottom of the ram and means for admitting water under lower pressure into the platen chamber. There is only one claim.

# 7500-S.H.P. TURBINE

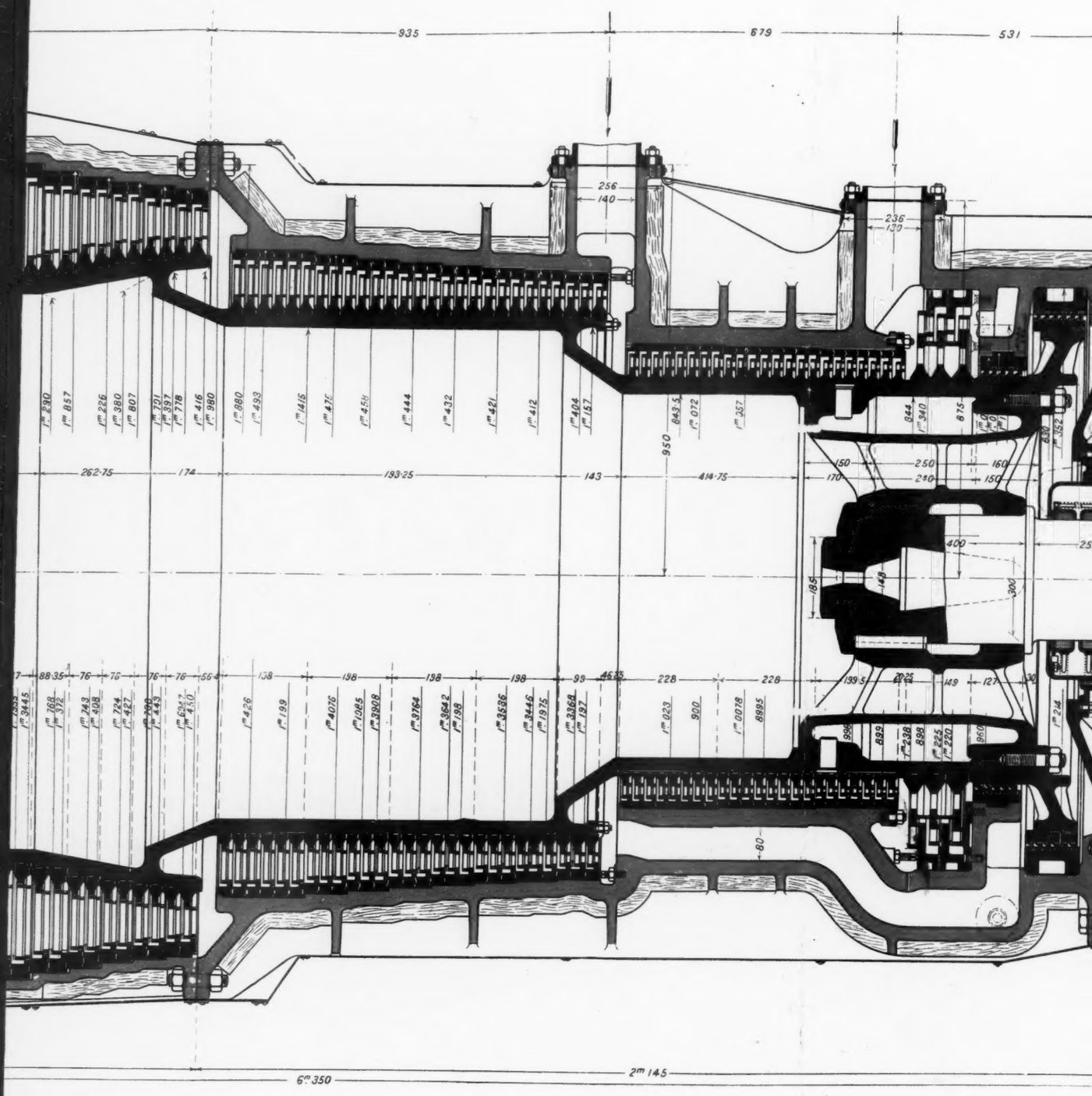


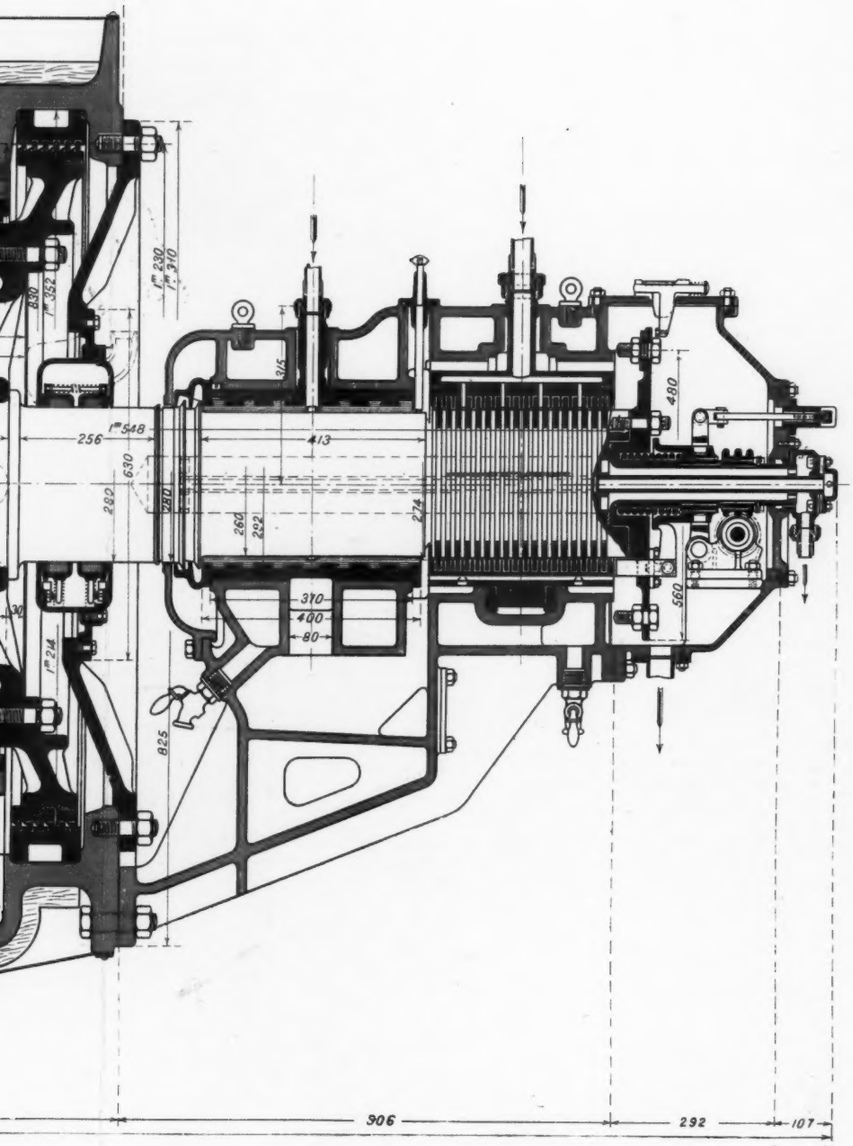

THE ENGINEER

Coloured Supplement, No. 4.
The Engineer.
June 5, 1914

# BINE OF THE FRENCH DESTROYER RENAUDIN

LA MAISON BREGUET, PARIS, ENGINEERS

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SWAIN Sc

## NOTES ON CENTRIFUGAL PUMPS.

By JAMES T. ROSSITER, M.I.E.E.

No. I.

BEFORE the arrival of the electric motor, when it was practically impossible to measure power and ascertain characteristics with any degree of accuracy,

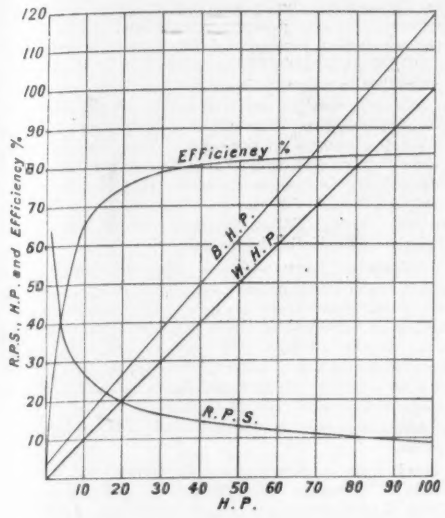



Fig. 1

and when efficiency was of less importance than to-day, the design of centrifugal pumps was more or less governed by rule of thumb. Conditions have now changed, and efficiency and accuracy of design have become of primary importance. The question is so complicated that few authors have done more than touch on the rudiments, and it has devolved upon the designer to take advantage of the opportunities afforded by experiment and test to ascertain for himself the essentials of efficient and durable design.

The author has had some years' experience, and has instituted a number of experiments, and it is hoped that these notes may be of general interest.

The author's experimental apparatus consisted of variable speed electric motors, carefully tested by brake, and standard electricity measuring instruments calibrated from time to time. Water measurements were made either directly into a large calibrated tank, or through orifices of ascertained coefficients. A testing column about 90ft. high, consisting of two 10in. pipes with the necessary valves and connections, and standard pressure gauges carefully tested from time to time, were used for the measurement of head. Speed measurements were made with tachometers frequently checked by a Harding counter. The experiments and tests were made under works test-room conditions. Some of the pumps were made specially for experimental purposes, and others were commercial pumps. The experiments selected for these notes were made upon pumps of about the same output, but of various designs for comparative purposes.

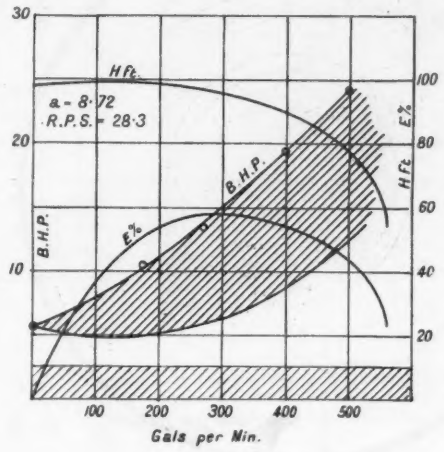



Fig. 4

*General.*—Before commencing upon particulars, it may be of advantage to make a general survey of the work, power, speed, and efficiency of pumps of various sizes. It is obvious that small pumps cannot be so efficient as large ones, and the diagram Fig. 1 is intended to give a general impression of the efficiencies and speeds that obtain in practice. The efficiency curve is established from a number of tests of pumps of different sizes, and it will be seen that it is similar to that of a dynamo. The curve of revolutions per second (R.P.S.) is confirmed in the same way, but it must be understood that there are deviations in both cases corresponding with differences in design. An examination of the efficiency curve may dispel misconception caused by the advertisement of high efficiencies which do not prevail except in the larger sizes.

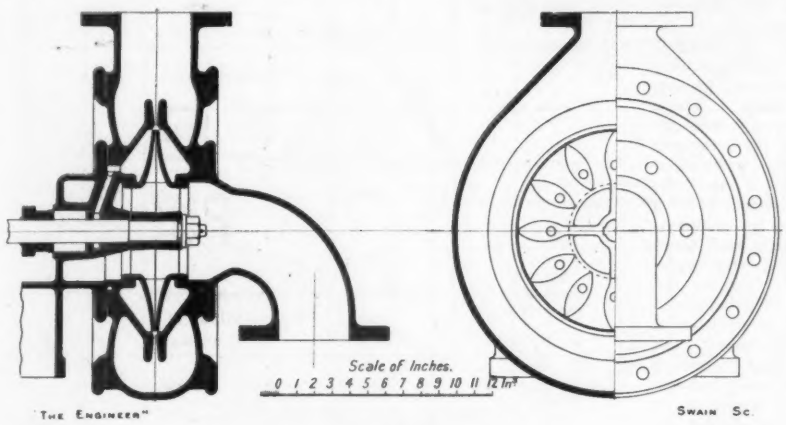



Fig. 2

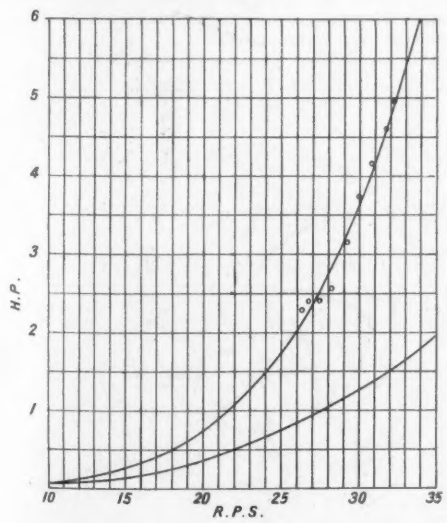



Fig. 3

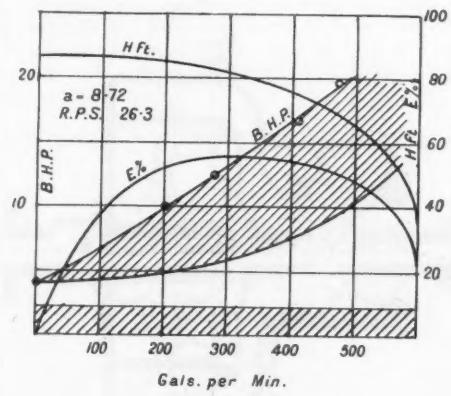



Fig. 5

*Permissible Velocities.*—Tangential velocity ($V_a$). The maximum velocity of a rotating impeller is that at which the material may be safely worked under the stress of centrifugal tension. This velocity is rarely reached in practice for considerations which will appear hereafter, and it would seem as though the efficient range of velocity is between 20ft. and 120ft. per second, which, according to the formula $h = \frac{V^2}{2g}$, is equivalent to velocity heads of 6.2ft and 223ft. respectively.

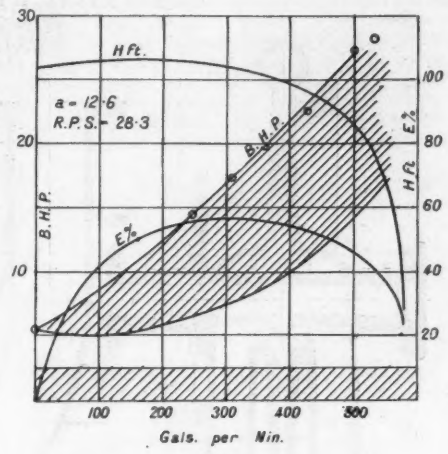



Fig. 6

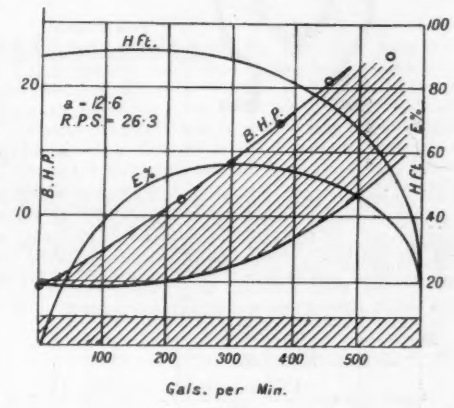



Fig. 7

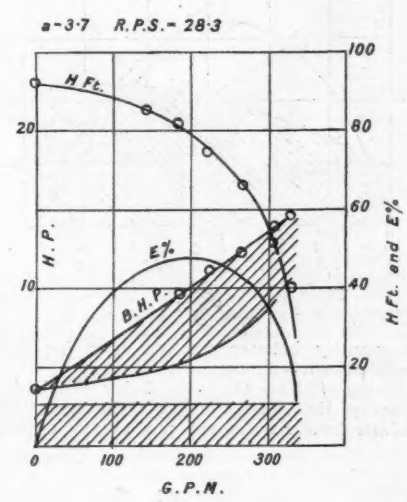



Fig. 8

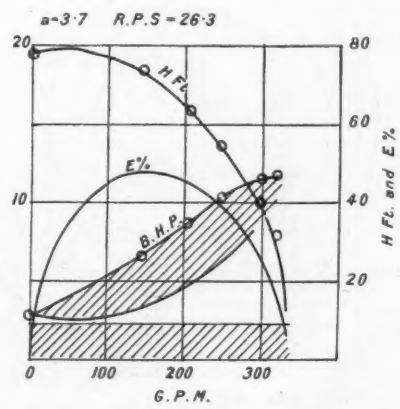



Fig. 9

*Rate of Revolution* (R.P.S.).—The speed of rotation should be suitable for a direct drive by a motor, or an

effective drive by belt or gearing. If it is found that the required head is beyond the comfortable and durable rate of revolution of a given impeller, it is usual to mount two or more impellers in series upon a common shaft in the form of a multi-cell or multi-stage pump. If the rate of revolution is too great to suit the efficient proportions of a single impeller for a given head and quantity, it is customary to divide the quantity between two or more impellers in parallel upon a common shaft.

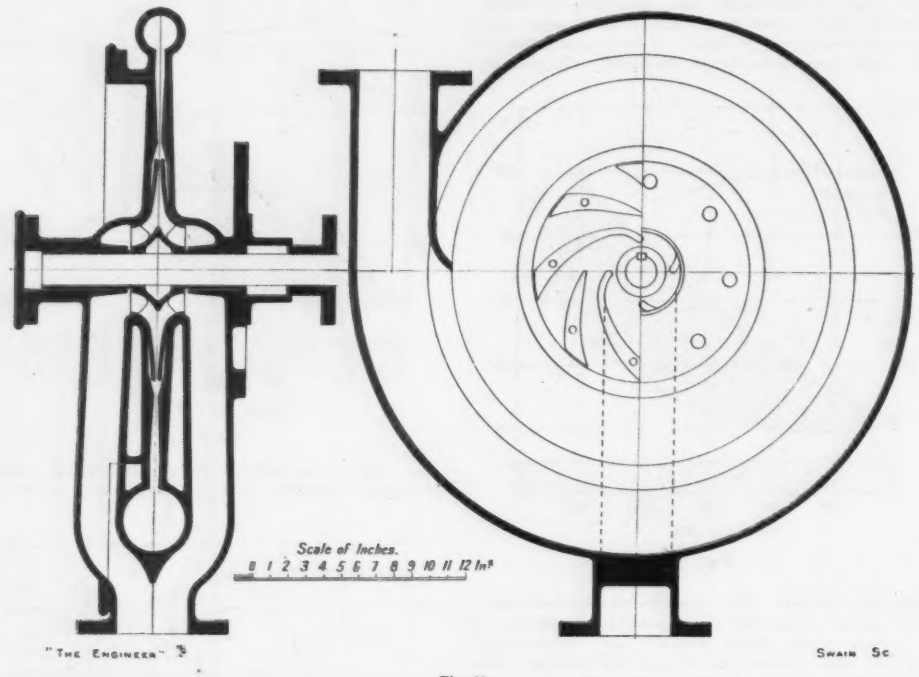



Fig. 10

*Velocity of Flow* ($V_R$).—In fixing standard sizes for pumps the velocity of flow must receive careful consideration. Buyers are not always acquainted with frictional losses in pipes, and are tempted to buy pumps having a high rate of flow through their branches because they think that the suction and delivery pipes may be of corresponding size. It is thought that the average frictional loss in delivery pipes of the same diameter as the branches should not exceed 4ft. head in every 100ft. of pipe. The suction branches and pipes should be somewhat larger. In special cases the velocity of flow in the delivery branch is converted into pressure by a suitable divergent nozzle connecting the delivery branch with the main. There exists a strong analogy between the performances of a direct-current dynamo and a centrifugal pump. In both cases characteristics can be varied by modification of design, and there is a likeness in the losses. But in the dynamo the losses can be ascertained or calculated with some degree of accuracy. An analysis of pump losses is not such an easy matter. The flow of water in a pump is not similar to the electrical condition in a conductor. The velocity of flow and the shape and surface of the passages in a pump affect the nature of flow to a marked extent with surprising results. Passages proportioned with care do not always run full. Perhaps the most extreme case investigated as far as possible by the author was that of a four-cell series pump. With the delivery valve closed a head due to four cells was obtained, but with an increasing flow the head rapidly fell off to that of two cells. The curved conversion passages were smooth, and proportioned to give a gradual reduction in velocity, and, according to experience, an efficient conversion should have taken place in each cell. The two inner cells were removed, and with the two outer cells connected the pump gave proper two-cell characteristics and performed efficiently. The design of the conversion passages of the inner cells was somewhat different from that of the outer cells. It appeared as though the velocity imparted to the water in the second cell was never converted, but continued through the second conversion passages and through the third impeller and passages. The nice curvature of the passages was altered and a more abrupt change of direction given, with the result that the cavitation disappeared and the pump behaved normally as a four-cell pump. Other examples of cavitation will be given in the following notes.

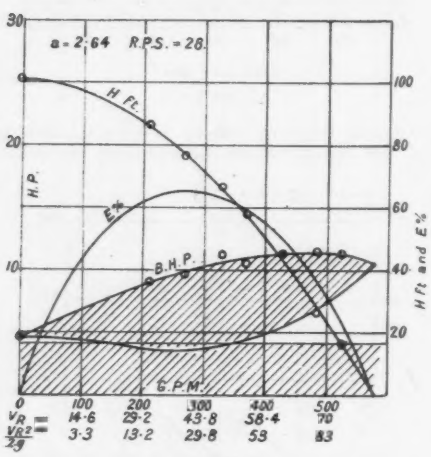



Fig. 11

*Analysis of Losses.*—Work lost may be broadly classed under three heads:—(1) That due to the rotation of an impeller in liquid; (2) that due to the conversion of velocity into pressure; (3) that due to the friction of flow. It appears to be impossible to measure the loss of head due to the friction of flow, but with smooth well-designed passages, and assuming a non-sinuous flow, the loss must be small. With a turbulent flow and cavitation the loss is probably far greater.

*Work Lost in Rotating an Impeller.*—In Professor Unwin's "Treatise on Hydraulics" some ably conceived experiments are formulated. But in attempting to apply the formulæ to the performance of pump impellers the author obtained impossible results.

One of the objects of the experimental pump—Fig. 2—was to ascertain the work lost in rotating an impeller under actual conditions as far as possible. Experimental impellers made in halves were tested under varying passage areas until the impellers were finally closed up. The loss due to stuffing-box and bearing friction was measured and deducted. Fig. 3 shows the plotting of work lost in friction with closed up impeller shrouds of polished brass 11in. dia-

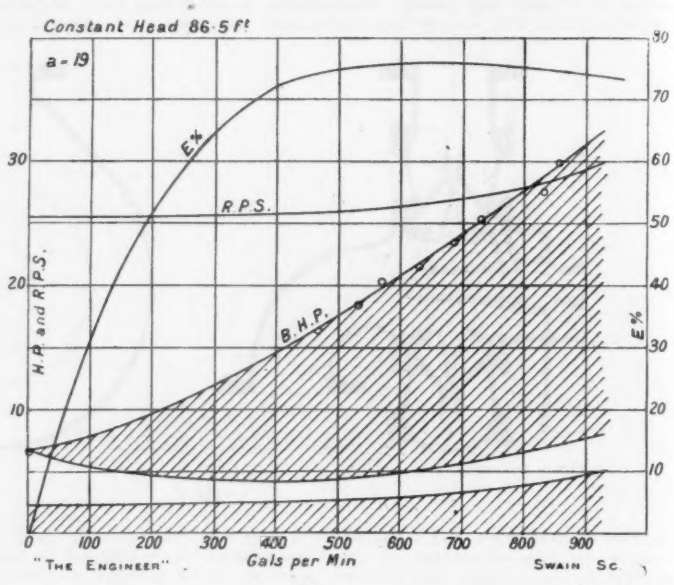



Fig. 13

*Cavitation.*—From numerous experiments and tests it would seem as though one of the greatest difficulties a designer has to contend against is cavitation.

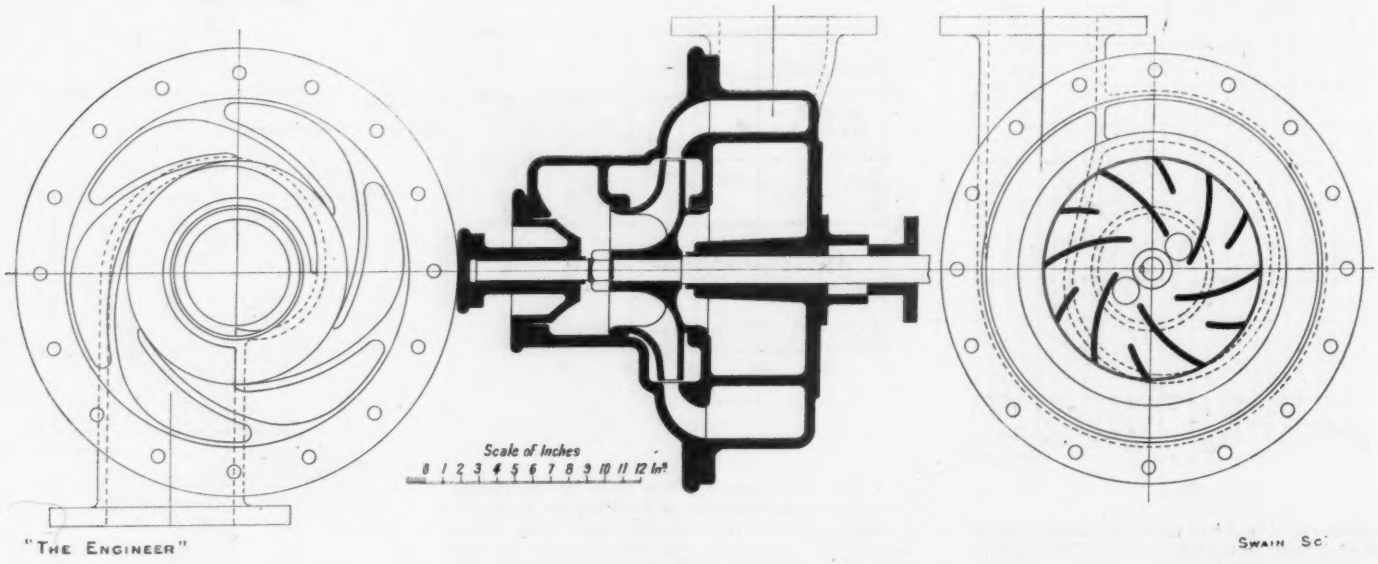



Fig. 12

meter rotated at various speeds in a charged pump—Fig. 2. Below it is drawn a curve in accordance with Professor Unwin's formula—

$$\text{H.P.} = \frac{623 \times 0.002\ N^3\ R^5}{550}$$

It will be seen that the curves coincide at a speed of 10 R.P.S. The author does not doubt the accuracy of or the deductions from Professor Unwin's experiments at the speeds given, but it would seem that at higher speeds the water becomes turbulent, and in all

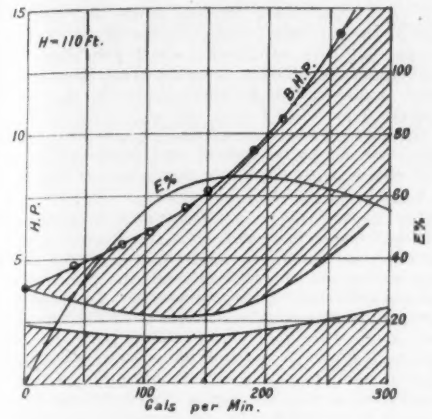



Fig. 14

probability cavitation takes place in the impeller chamber due to the motion imparted to the water. Under these conditions it is impossible to assume usual coefficients of friction, and all that can be done is to find a formula to fit the readings and check it from the tests of impellers of different diameters. Such a formula partly based upon Unwin's reasonings is this—

$$\text{H.P.} = \frac{0.123\ N^4\ R^5}{550}$$

in which H.P. = the work expended in rotating an

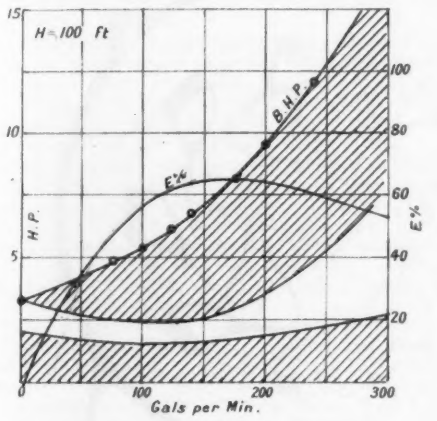



Fig. 15

impeller of R feet radius in fresh water at N revolutions per second. From this formula a close approximation can be made, and the remaining losses can also be approximately deduced.

Figs. 4, 5, 6, 7, 8, and 9 give some of the analytical diagrams of the performance of the experimental pump—Fig. 2—under several conditions. The upper shaded area of each diagram represents useful work, the lower shaded area represents impeller losses, and the unshaded area between gives the remaining losses.

The impeller from which these diagrams were plotted was made in halves, and the passages were of gradually decreasing area towards the periphery. The area at the periphery (*a*) was reduced by turning down the blades, and at each reduction tests were

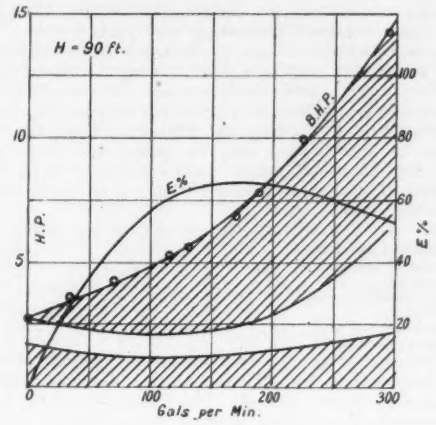



Fig. 16

made. The effect of the reduction is clearly shown. A number of experiments were made to ascertain the effect of altering the width of the conversion chamber,

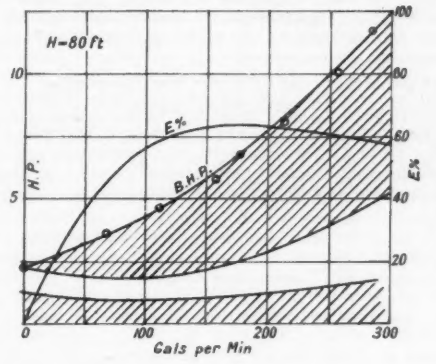



Fig. 17

but the results were not sufficiently pronounced nor good enough to do more than justify the opinion that the conversion chamber was too small in diameter

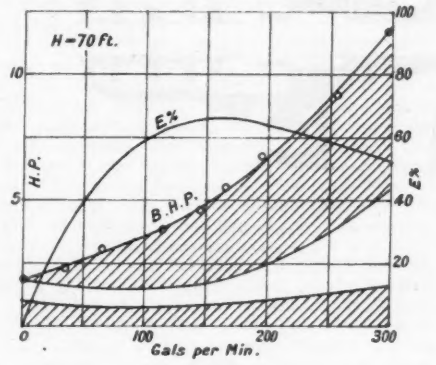



Fig. 18

for efficient conversion. Fig. 10 shows the form adopted for another experimental pump. The impeller was of polished brass, 12in. in diameter, and

making friction tests with impellers having no peripheral openings it was found that the motion imparted to the water by friction was converted into head, and that a partial vacuum was formed in the impeller chamber near the "eyes" of the impeller. This vacuum was sufficient to cause leakage past the running joints at the eyes, and the water of leakage was actually pumped against a total head of 10ft. In the pump—Fig. 10—impeller friction appears to have assisted in the production of head, and as the proportions of the conversion chamber were such that the conversion

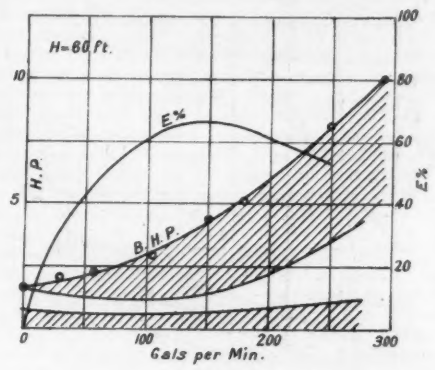



Fig. 19

losses were almost negligible, the work done by impeller friction more than balanced such losses. In continuing the experiments a sudden increase of power indicated mechanical friction, and on making an examination it was found that one of the impeller shrouds was cracked in all directions near the eye. Discolouration pointed to local heating, although water was passing—an indication of cavitation both within and without the impeller near the eye.

A further experimental pump—Fig. 12—was made. The body was designed to accommodate impellers having different passage areas, and covers containing conversion passages of different areas and curvature. Fig. 13 gives the plotted results of some of the experi-

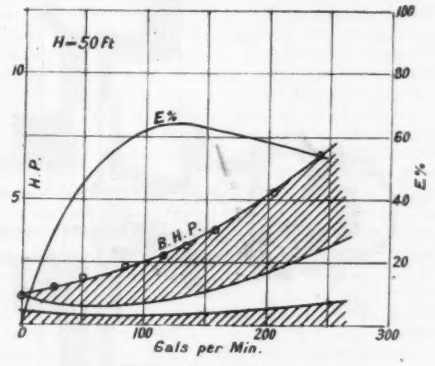



Fig. 20

ments made with the impeller and cover made in accordance with Fig. 12. The performance of this pump was unstable. It will be seen that the readings of the tests graphically represented were as consistent as could be expected under works conditions, but some of the other tests were so irregular and the efficiency so uncertain that it was thought advisable to investigate. Gauges were fixed to various parts of the pump, and under certain conditions an abnormally low pressure was found near the centre of the "eye." This appeared to be due to the formation of a vortex cavitation, and from instability of

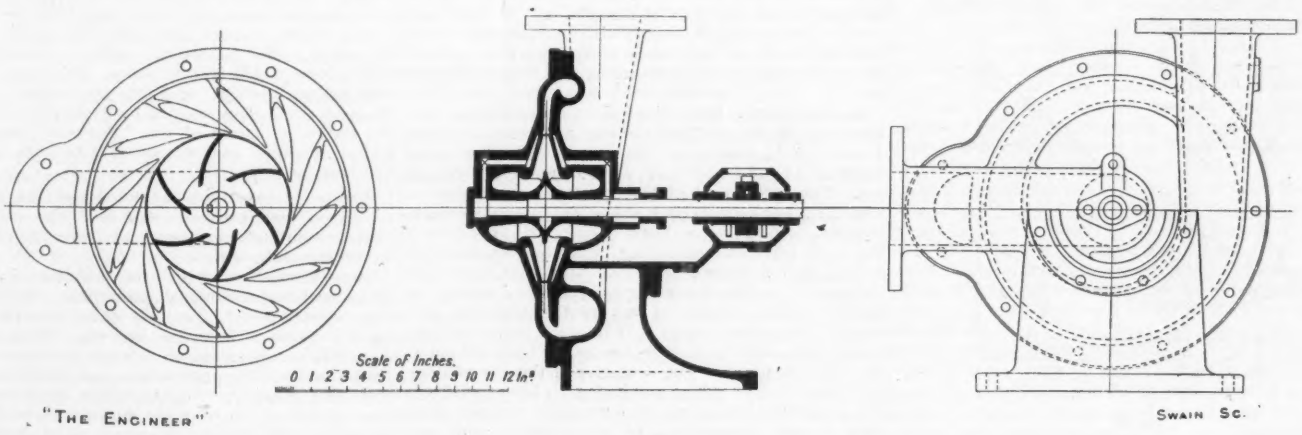



Fig. 21

the area of the passages at the periphery was 2.64 square inches. A number of tests were made at various speeds, and a typical diagram is given—Fig. 11. The performance of this pump is remarkable. In rotational speed it appeared as though the cavitation was continued through the impeller passages. It will be noted that the entrance to the eye is volute shaped, and it was thought that this might have

contributed to cavitation. Guides were therefore fitted to the entrance, but without effect. The low pressure in the eye continued. This led to a consideration of the relative diameters of the eye and of the impeller. In this case the ratio $\frac{d}{D}$ was 0.51.

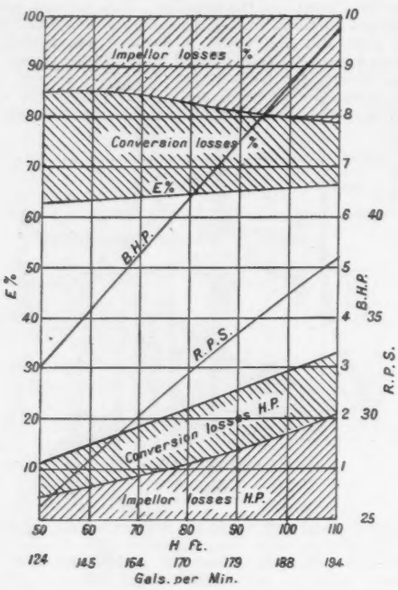



Fig. 22

Investigations were made on pumps having impellers of less ratio, and the opinion was formed that for heads up to 50ft. the ratio should not be more than

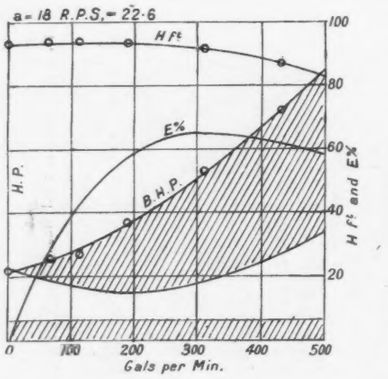



Fig. 24

0.45, and for greater heads it should not exceed 0.4. This point will be discussed further.

Figs. 14, 15, 16, 17, 18, 19, 20 represent tests made on the pump Fig. 21, and Fig. 22 summarises the best results obtain in these tests. It may be of interest to note the difference in the analysis of losses at constant speed shown in former diagrams, and those at constant head shown in these.

Fig. 23 represents a continental pump whose characteristics and analysis are shown in Fig. 24. These various results were selected from a large number of tests representing the characteristics of pumps of widely divergent design, but approximately the same duty. It is impossible to make more than a very rough comparison, because the pumps were working on the unstable part of the general efficiency curve—Fig. 1. The great difference in the dimensions of the pumps may be noted, and a rough approximation of output for weight may be of interest to the manufacturer. This is shown in the following table :—

| | Fig. 2. | Fig. 10. | Fig. 12. | Fig. 21. | Fig. 23. |
|---|---|---|---|---|---|
| Weight of parts illustrated, cwt. | 2¼ | 5 | 6 | 2 | 7½ |
| Head, feet | 96 | 72 | 86.5 | 90 | 92 |
| Most efficient output, W.H.P. | 8.7 | 6.5 | 15.75 | 7.3 | 8.35 |
| Efficiency, per cent. | 58 | 64.4 | 76 | 66 | 65 |
| W.H.P. per cwt. | 3.5 | 1.3 | 2.6 | 3.65 | 1.1 |
| R.P.S. | 28.3 | 28 | 26.5 | 34.3 | 22.6 |

Reservations must, of course, be made for differences in speeds.

## THE GERMAN NAVAL ARCHITECTS.

No. II.*

Thursday, May 28th, was devoted to a visit to the Zeppelin Works in Friedrichsbafen, where the aluminium framework of a new airship was inspected, the wonderful lightness of the construction appealing with special force to the naval architects and other engineers assembled.

A paper was read by Count von Zeppelin on

"Zeppelin Airships."

The author said he got his idea of building airships from a wish expressed in a paper read by the well-known German Postmaster-General, Stephan. He had realised from the first that such a ship must be of large dimensions. Of the known media for raising weights in air, hot air was excluded on account of the weight required to produce it, and only hydrogen gas remained. He had been unable at first to use goldbeater's skin for the gas cells, as he had wished, because it was not flexible enough, and he had had to use cotton impregnated with caoutchouc. For the framework he had chosen aluminium after a long series of experiments at Staatsrat von Bach's laboratory.

In view of the large dimensions necessary for the structure, Count von Zeppelin had early foreseen that doubts would arise as to his reason. The first ship required 11,300 cubic metres (390,000 cubic feet) of gas. The upper part of the envelope was of cotton and the lower part of thin silk. The motor weighed 30 kilos. (66 lb.) per horse-power and consumed 500 g. (1.1 lb.) of benzine per brake horse-power per hour. A 9 horse-power motor used 200 litres (44 gallons) of cooling water during ten hours' work. A French cooling apparatus was used in the later airships. The screws were 1.15 m. (3ft. 9½in.) in diameter and had each four blades. Their efficiency was 71.3 per cent. The diameter of the gas-holding body was 11.6 m. (38ft.) and its length 128 m. (420ft.). To hold this large structure together the use of a rigid system seemed to be unavoidable and was adopted. The suspension of the weights at half-length of the ship would have entailed a stronger and therefore heavier structure, and in consequence two cars were adopted, the one supported by the fore-body and the other by the after body.

The sectional area of the first ship was 106 square metres (1140 square feet). The tapering ends were each 16 m. (52ft. 6in.) long. The twenty-four-sided hull was divided by transverse partitions into seventeen compartments. Aluminium of a specific gravity of 2.7 and a tensile strength of 33 kilos. per square millimetre (21 tons per square inch) was used for the framing. The weight of the latter was 5825 kilos. (5.6 tons). The upper part of the envelope weighed .17 kilo. per square metre (.024 lb. per square inch), the lower part .15 kilo. per square metre (.021 lb. per square inch).

A 14.7 horse-power Daimler motor was carried in each of the two cars; these engines drove two right-handed and two left-handed screw propellers. The mechanical installation weighed 1970 kilos. (1.929 tons), equivalent to 67 kilos. (147.4 lb.) per horse-power.

This first vessel proved that an airship could be built that could be steered and manœuvred. The next step was to adapt it to war and merchant work.

A stronger and more gas-tight envelope was attained after the proper treatment of goldbeater's skin had been discovered. To give greater carrying capacity the dimensions had to be increased for the new airship, so far as this could be done without making her unhandy and unhousable. Improvements were also made in the framework. With the increased size more power and greater speed could be given. Messrs. Maybach Vater und Sohn supplying a special type of motor with a small consumption of benzine. Among additions made were a third motor, an installation for spark telegraphy, an ascent to a platform at the top of the hull, and a set of searchlights.

The new airships of the "Sachsen" class were thus 8 m. (26ft. 3in.) longer, 3.2 m. (10ft. 6in.) larger in diameter, and 8000 to 9000 cubic metres (280,000 to 320,000 cubic feet) greater in volume than their prototype. The ends had, in them, become more pointed and the section of the hull had become seventeen-sided instead of twenty-four-sided. Improved structural arrangements had entirely removed the deflections of 25 cm. (about 10in.) that had occurred in the first ship.

The fifth ship built had covered the distance of 1194 kiloms. (742 miles) to Vienna in thirty-eight hours. The speed of the Sachsen was 72 kiloms. (44¾ statute miles) per hour, with 1000 kilos. (about 1 ton) weight of crew and 3000 kilos. (nearly 3 tons) of cargo, the radius of action thereby being 2200 kiloms. (1367 statute miles), or against the wind 1480 kiloms. (about 920 statute miles). It was thought that, allowing for unfavourable conditions, the radius of action of the "Sachsen" class might in future work out at about 1000 kiloms. (about 620 statute miles).

The question of the capabilities of the airship as compared with the aeroplane had, the author said, been specially investigated by Herr Dornier, who would now take his place.

Herr Dornier set forth the principles familiar to naval architects, of the displacement, carrying capacity, speed, power, &c. He drew attention to the rapid increase of carrying capacity, radius of action, &c., that accompanied an increase of size, but stated that the costs of construction and maintenance also rose very rapidly. A comparison between airships and aeroplanes showed the superiority of the latter at speeds of 90 kiloms. (56 statute miles) per hour and over.

Count von Zeppelin, who spoke again after Herr Dornier, pointed out that aeroplanes travelling over long distances at low speeds were especially subject to retardation by contrary winds. For very long distances such as those of 3000 kiloms. (1864 statute

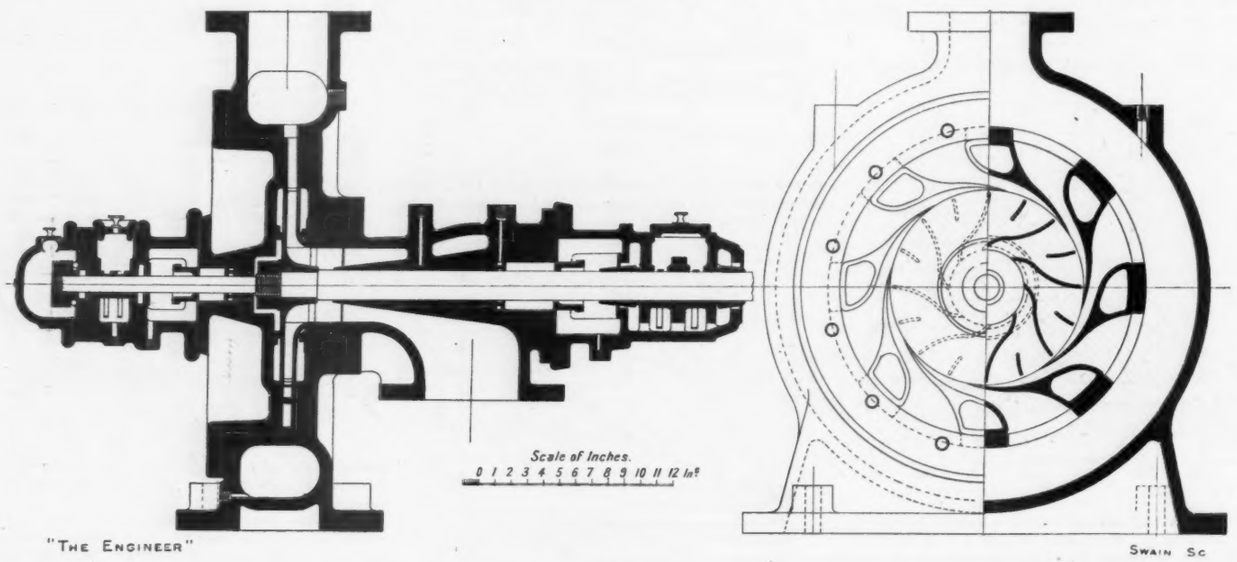



Fig. 23

* No. I. appeared June 5th.

miles) or more, over the Atlantic, &c., the airship was superior to the aeroplane. Count von Zeppelin finally referred to the dangerous hydrogen gas used. He thought it quite possible that a non-inflammable gas might some day be discovered, and the airship would then be the safest of all possible vessels.

In the afternoon exhibition flights were made with a number of hydroplanes of the Flugzeug-bau-Gesellschaft, of Friedrichshafen. One of these craft, which excited special interest among the visitors, took the form of a complete boat. Pressed to the necessary speed, it rose completely out of the water.

On Friday, May 29th, Fregattenkapitän Rollmann read a paper on

"STEAM SHIPPING ON LAKE CONSTANCE,"

the rise and development of which he traced. The pioneer steamer had, he said, left Friedrichshaven on her first voyage ninety years ago and had kept up a regular service to the Swiss shore, which she visited four times a week. Seven years earlier the mechanician, George Bodmer, of Zurich, had had a ship built called the Stephanie, in Constance, the engine for which had been ordered from Great Britain. She ran aground in the Rhine in launching and had never gone on service. The order for the engine was countermanded. The real founder of the service was a Mr. Church, who was American Consul in Bordeaux.

On July 3rd, 1824, a Friedrichshaven Steamboat Company was founded with a capital of 66,000 fl., half of which was held by the King of Würtemberg and the State. The first vessel was launched amid great festivities and named the Wilhelm. Her dimensions were:—Length, 30.6 m. (about 100ft.); breadth, 5.37 m. (17ft. 7in.); and draught, .9 m. (2ft. 11½in.). Her displacement was about 90 tons and she had a low-pressure beam engine of 20 nominal horse-power, built by Fawcett, of Liverpool. Her speed was 10½ kiloms. (6½ statute miles) and she carried 124 passengers. The first year's working yielded a dividend of 5 per cent. The next vessel was a somewhat smaller one, called the Max Joseph, and had paddles with the then newly invented feathering floats. She kept up a service between Schaffhausen, Rorschach, and Lindau. The hull of the Wilhelm in course of time became so defective that a new one was built, to which the engine was transferred in 1832.

In 1829 a Badian company was formed for Constance and the Rhine, in which the State took shares. Two vessels were built—the Leopold, of 32½ m. (106ft. 7½in.), and the Helvetia, of 30 m. (98ft. 5in.), with speeds of 13½ kiloms. (8.38 statute miles) and 11½ kiloms. (7.14 statute miles) respectively.

A third company was formed in Lindau in 1835, and, difficulties being smoothed away by the help of the King, an iron steamer was ordered from W. Fairbairn, in Millwall, and arrived in pieces in 1837, to be put together by the engineer of the company, Herr Lämmlein. She was then named the Ludwig. She was 36.6 m. (120ft.) long and had a speed of 15 kiloms. (9.32 statute miles).

In 1842 disagreements arose between the companies, and sharp competition began. The original Friedrichshafen company, now named the Würtembergische Bodensee Dampfschiffahrts-Gesellschaft, in 1839 ordered a vessel from Messrs. Escher Wyss and Co., of Zürich, who built her in Rorschach. The original name of the vessel, the Kronprinz, was altered first to König Karl and then to Würtemberg. This vessel made the name of Messrs. Escher Wyss and Co., who now built almost all the ships on Lake Constance. The new vessel was 41.5 m. (136ft.) long, 5.28 m. (17ft. 3⅞in.) broad, and 2.58 m. (8ft. 5½in.) in depth. Her draught was 1.2 m. (3ft. 11¼in.) and her displacement 1367 tonnen (1345 tons). Her first engine, of 50 nominal horse-power, drove her at a speed of 15 kiloms. (9.32 statute miles): later alterations gave her an engine of 200 indicated horse-power and a speed of 21 kiloms. (13 statute miles). Additional vessels were now built for the other companies also. Keen competition between the three companies concerned soon afterwards created impossible conditions, and an agreement was finally come to by which the different States and the steamboat companies worked together and arranged a service in common.

The first railway laid to the lake in 1847 found nine steamers plying on it. In later years several other railways appeared upon the scene, and a train service right round the lake was provided.

In 1854 the Würtembergische Staatseisenbahn bought up the Würtembergische Dampfboot Gesellschaft, the pioneer concern. A Swiss company next appeared, but shortly afterwards sold its vessels to the Swiss North-Eastern Railway. This transaction was followed by the formation of another Swiss steamboat company for the Lower Lake and Rhine. Two of the remaining private companies were soon afterwards sold to railways and the era of railway train ferries then began.

In the first years of the steamboat services there were no rules of the road, and arrangements of all kinds, in the harbours and elsewhere, were very incomplete. The captains were men of figures and account books, and had to navigate their vessels at the will of their mates, who were sailors. Many accidents thus occurred. In 1864 regulations began to be made, and three years later the three Governments conjointly issued a number of steamboat and harbour regulations, which, as regards fog signals and the rule of the road, were still very imperfect.

In the middle of the eighties an Austrian company with an ex-naval officer at its head established another service on the lake. Under the influence of trained seamen the regulations were gradually improved till, towards the end of the nineties, they were brought up to the general level reached by services elsewhere. The plan finally adopted was that police regulations, passenger fares, and conditions of service on the vessels were established conjointly, the carriage of goods remaining the affair of the individual companies. The lake fleet now consisted of thirty-seven passenger vessels, thirteen railway ferry barges, one railway ferry steamer, and eleven tugs. The number of passengers carried in 1911 exceeded 4½ millions.

In concluding these brief reports it may be of interest to add a few words about

THE STUTTGART LABORATORIES,

which are perhaps less known in Great Britain than they deserve to be. Their creator—Professor C. von Bach, Staatsrat, and Dr. Ing., of Stuttgart—has been a prominent figure among German engineers ever since experimental trials of machinery and the testing of materials began to be conducted on scientific lines. He was called out of the workshop to be Professor at the Stuttgart Technical College in 1878. A laboratory did not then exist, and in order successfully to carry out his work as Professor of Hoisting Apparatus, Elements of Machinery, the Laws of Elasticity and Steam Engines and Boilers, he at once set to work to create places and means of instruction worthy of the name and to elaborate scientific principles that now pervade the engineering professions. Largely through the influence of the Würtembergische Bezirksverein, a grant of M.16,000 (about £800) was obtained from the Government, and the beginnings of a laboratory were installed in a cellar of the College. This establishment was opened in 1884, and for 5½ years Herr v. Bach carried it on with one workman. In the course of years about £2500 more were obtained and spent in its development, and the staff was gradually increased. Machinery was purchased piecemeal. For example, a cylinder was obtained in 1880; a few years later the means at disposal admitted of the purchase of the remaining parts of a single-cylinder engine. Room for the engine was obtained in 1886, in connection with the existing boiler-room of the College warming apparatus, which then supplied steam at 2½ atmospheres for instruction purposes; the engine bed-plate was so arranged that it could take a two-cylinder engine at some future day. In 1888 came a grant of about £170 and other help, which enabled a separate high-pressure boiler to be put down, the feed pump, injector, &c., being placed at disposal by an engineering firm and paid for gradually by instalments. A second cylinder, a surface condenser, measuring instruments, &c., were gradually acquired.

The students could now be trained in the operation of the machinery, including the firing of the boiler, and arrangements were also made by which they could learn at the works of some of the engineering firms. The institution had by this time made a place for itself, and further means and a greater amount of elbow room had become absolutely necessary. The late Minister of State, Dr. v. Sarwey, took special interest in the work, and a sum amounting to about £25,000 was appropriated to the building and equipment of a separate establishment at Berg, in the valley of the Neckar, a place about 3½ kiloms. from the College, where sites were cheaper and the noise of working would not be a nuisance to neighbours. The new establishment was arranged to deal with energy in the forms of heat, electricity, steam, high-pressure water, compressed air, &c. Investigations were at once to be rendered possible in the domains of hydraulics and heat transmission. Those relating to turbines and other water motors were meanwhile to be left for future consideration. In addition to lecture halls and dwelling and office rooms, an engine-house, boiler-house coal-house and power gas and gas motor rooms, as well as a smithy and workshops, were erected.

A horizontal four-cylinder triple-expansion main engine of 100 to 200 horse-power, with high-pressure cylinders of 250 mm. (9⅞in.), intermediate and low-pressure cylinders of 400 mm. (15¾in.), and a stroke of 760 mm. (30in.), was put down. It is arranged for purposes of instruction, and can be so adjusted as to represent as many different types—compound, triple-expansion, tandem, &c.—as possible, and to work under all imaginable conditions of pressure, cut-off, &c. It can be worked with superheated steam to about 270 deg. Cent. initial pressure. By means of belting it drives a number of pumps in the cellars. These pumps are arranged to work with different kinds of valves. The working pressure can be raised to a maximum head of 100 m. (328ft.), the revolutions reach 70 per minute, and the maximum delivery is 250 c.m. (55,000 gallons) per hour.

Another engine of 50 horse-power of the vertical pattern for steam superheated to 360 deg. Cent. is, like the larger one, adapted for instruction purposes. It has two horizontally arranged single-acting high-pressure cylinders of 220 mm. (9in.) diameter, a vertical double-acting low-pressure cylinder of 400 mm. (15¾in.) diameter, and a stroke of 350 mm. (13¾in.). It runs at 170 revolutions, with 12 atmospheres initial pressure.

A travelling crane of a carrying capacity of 4000 kilos. (about 4 tons) can be used to dismount the larger parts of the pumps in the cellar below. Valves, indicators, pressure gauges, and a centrifugal pump worked by a gas motor also belong to the equipment.

The boiler-room contains three boilers with heating surfaces of 100 square metres (1076 square feet), 15 square metres (161 square feet), and 8 square metres (86 square feet) respectively. The equipment now comprises almost every variety of engine and boiler appurtenance. The chimney of 35 m. (115ft.) in height is provided with draught and temperature measuring instruments, and with means of access by ladders, with suitable safety appliances, by which observations can be made at different heights. Lighting and power gas appliances of various kinds are represented; gas-power engines of 8 and 25 horse-power respectively can be driven by both kinds of gas. There is a well-appointed workshop above the gas-motor room and in connection with the smithy.

What could be done to render the installation conveniently available for every purpose of study and to enable as many students as possible to follow the lectures was done during the erection and equipment of this laboratory. Subsequent to the installations above described came plant for the determination of the heat value of fuel, an ammonia ice machine for 1300 cal. per hour, a uniflow superheated steam engine with cylinder diameter of 360 mm. (14¼in.), a stroke of 450 mm. (17¾in.), a working pressure of 14 atmospheres, and an initial steam pressure of 350 deg. Cent. A water-tube boiler for a working pressure of 20 atmospheres and 150 square metres (492 square feet) heating surface is shortly to be installed. A superheater and an economiser are also to be provided, and the boiler is to be so arranged that it can be fired by several different systems. Another new acquisition will be a steam turbine installation that can work at a maximum of 500 E.H.P., making 3000 revolutions per minute.

The machinery of the material testing laboratory consisted originally of two vertical compression test machines for loads of 450 and 150 tons; a horizontal tensile, compression, bending, torsion and shearing machine, for a load of 100 tons and a torsion moment of 600 cm.-kilos. (about 2¼ inch-tons); a smaller horizontal machine for tensile, compression, bending, torsion and shearing tests, for loads up to 60 tons; a vertical machine used for all purposes, but principally for tensile tests at high temperatures, for loads up to 50 tons; a vertical compression machine for cement cubes, load 30 tons: a vertical machine for simultaneous tensile and torsion tests, load up to 25 tons and torsion moment up to 16,500 cm.-kilos. (about 6½ inch-tons); a wire-twisting machine, twisting moment up to 600 cm.-kilos. (about 2¼ inch-tons); a machine for testing cement pipes, load up to 10 tons; a vertical machine for testing plates, load up to 10 tons; a vertical machine for tensile tests, load up to 5 tons; a tensile testing machine for wire, load 1.2 tons; a tensile testing machine for cement, load up to ¼ ton. An accumulator plant for high-pressure oil served the 500-ton, 150-ton, and 5-ton machines, pressure 150 atmospheres. In the 60-ton and 50-ton machines the loads were applied by spindles driven by electromotors or by hand.

Then there are piston-testing arrangements for pistons of 1850 mm. (6ft. 0¾in.) and 1000 mm. (3ft. 3⅜in.) diameter, arrangements for determining distortions of furnace tubes, appliances for notched bar and drop tests, and hammers and tools of various descriptions.

The later additions include a vertical machine for bending tests, in particular for reinforced concrete, maximum load 160 tons; a vertical machine for beam-bending tests, maximum load 50 tons; a vertical machine for compression and bending tests, especially for bending cast iron samples and for Brinell tests, maximum load 10 tons; a vertical machine for ball pressure tests, maximum load 3 tons; and a number of machines for smaller tests, machine tools and other appliances. Appliances for metallographical investigation, though of comparatively recent date, have, in Professor Baumann's hands, done a great deal of good work.

The laboratories form a branch of the Technical College, but they are not devoted only to purposes of instruction. Professor v. Bach is, indeed, entrusted with investigations of all kinds, but especially for the building and engineering works from all parts of Germany and also from abroad. It is found that this connection with the commercial side of engineering puts life into the College work, and keeps it in touch with all the latest developments.

Of the work done by the laboratories an imperfect idea may be obtained from the long list of publications of results of investigations. Up till April 30th of this year these numbered 182, the large majority of which bore Professor v. Bach's name. When it is remembered that only a part of the investigations are allowed to be published and that standard works by Professor v. Bach are to be found in every German home of engineering, the volume of the work done by the Stuttgart Laboratory and its chief may be partly realised.

## SINGLE-PHASE RAILWAY IN THE EASTERN PYRENEES.

No. I.

PRIOR to July of last year the cities of Saint Laurent de Cerdans and Prats-de-Mollo, situated on the Spanish frontier, were without railways. Connection with the Midi line could only be obtained by coaches, and the journey was difficult and precarious, but with the opening of a new electric line connecting Arles-sur-Tech, Saint Laurent de Cerdans, and Prats-de-Mollo, travelling facilities have been greatly improved, and the journey between the two former places can now be covered in about 1 hour 25 minutes. The scenery met with in these parts is very beautiful, and the line will no doubt be greatly patronised by tourists, and will also serve to increase the value of manufactured and agricultural products of the places through which it passes. The work was carried out at the joint expense of the authorities of the Pyrénées Orientales Department and the Pyrénées branch of the Midi Railway, the latter dealing with all the electrical work. The main portion of the contract was awarded to the Ateliers de Constructions Electriques du Nord et l'Est, Jeumont, Nord. There is an abundant supply of water power in this part, and this, coupled with the general conditions of working, caused the engineers to decide on the employment of electric traction. The railway is worked as two distinct parts. Trains start at one end at Arles-sur-Tech at a height of 269·6 m. above the sea level and run to Prats-de-Mollo, which is 751 m. above the sea level. The other section, as the map—Fig. 1—shows, goes to Saint-Laurent de Cerdans, which is 674·98 m. above the sea level. There is a common track for both lines between Arles-sur-Tech and Les Manyaques. The length of the first line is 20·720 m., and that of the second 18·65 m. Only one important structure had to be built, which is a viaduct at Les Manyaques, consisting of seven masonry arches of 10 m. span, and a steel bridge 42·55 m. between abutments, which spans the river Tech on the Saint Laurent branch. The line, which has a gauge of 1 m., borders for the greater part of its course the high road, and the remainder is on the flank of a mountain. The maximum gradient is 50 mm. per metre. There are many curves. On 29 kiloms. of line, exclusive of sidings, there are about 2750 m. of track on curves with a radius of 20–30 m., 4500 m. of curves with a radius of 35–40 m., and as many metres of curves with a radius of 40–50 m. There are also curves with a radius as small as 20 m.

On account of the winding character of the line, special attention had to be paid to the design of the rolling stock. Guided by the able engineers of the Midi Railway, however, the contractors have succeeded in turning out rolling stock which has proved highly successful. Each train is used for passengers and goods and is made up of one motor coach, weighing 28 tons empty, and a certain number of trailer coaches for passengers and goods, a complete train weighing 50 tons. Three trains are run continually in each direction, and are timed to meet other trains at Arles-sur-Tech. It is possible to haul a weight of 40 tons, a full train complete weighing 70 tons. The maximum speed is 26 kiloms. per hour. On festival and fair days at Prats and Saint Laurent it is necessary to put an extra 50-ton train into service. As the railway traverses the roadway the use of a third rail was out of the question, and a conduit system proved too expensive. It was therefore necessary to use an overhead wire. It was decided to work the railway on the single-phase system at a pressure of 6000 volts and at a periodicity of 25 cycles per second, for by adopting this high pressure it was possible simply to feed the lines at one point without an excessive voltage drop.

Fig. 1—MAP SHOWING ELECTRIFIED LINES

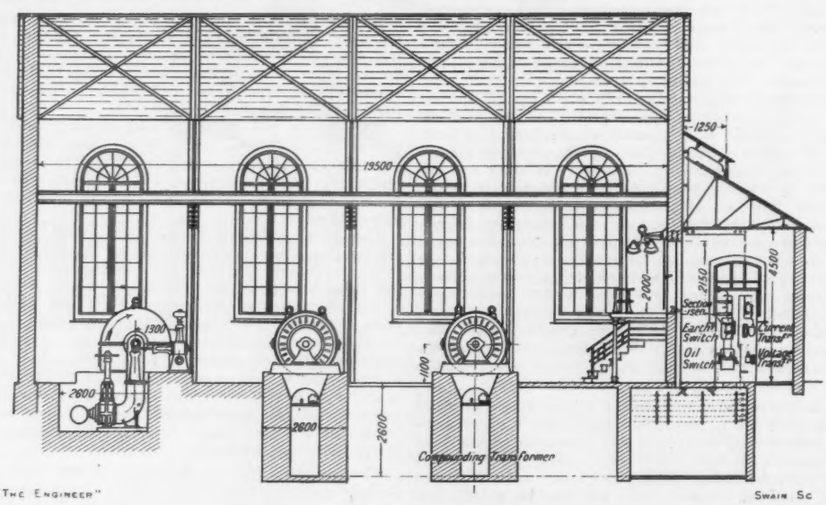



Fig. 2—ARRANGEMENT OF POWER HOUSE

The generating station is at Pury Redon, near the centre of the line, and its position is marked on the map—Fig. 1. It is worked by water, which is stored in a reservoir built by the authorities of the Pyrénées Orientales Department; the position of this reservoir is also marked on the map. The capacity of the reservoir is 8000 cubic metres, the total fall about 72ft. Water is supplied to the reservoir with the help of a dam on the river Tech and about two kiloms. above Pury Redon. A canal connects the dam with the reservoir. At low water the normal delivery of the canal is 850 litres per second, but it rises to 1100 litres at high water. Water enters the turbines in the power-house through three separate steel conduits 1130 m. long. In the power-house there are three water turbines coupled to single-phase alternators. At a speed of 375 revolutions per minute each turbine develops 450 horse-power. The efficiency of the turbines at full load is 76·5 per cent. The alternators, which generate at 6000 volts, are of the revolving field type and have eight poles. They each develop normally 200 kilovolt-ampères with an efficiency of 90·5 per cent., but they can develop 300 kilovolt-ampères if necessary. Each machine has its own exciter, which is driven through a train of gearing having a ratio of 1 : 2. The exciters are compounded in accordance with the system devised by La Tour, which not only compensates the drop in the generators, but also the drop in the line. An elevation and cross section of the power-house are given in Figs. 2 and 3 respectively. From the former it will be noticed that the switchboard is mounted on a gallery, the switches themselves being placed in an adjacent building, together with current transformers, water-jet arresters, choke coils, and transformers for auxiliary services, all of which are enclosed in cells of reinforced concrete. There are eight switchboard panels, one for each generator, one for general control, one for each part of the line, and one for auxiliary services, such as lighting, &c. All the switches on the latter panel are low-tension switches. For each alternator there is a high-tension switch, a current transformer, a maximum current time relay, a voltage transformer, and wattmeter. A shunt rheostat field switch and ammeter are connected in each field circuit. In circuit with each feeder is a time limit switch, a choke coil, an ammeter, and sectioner. Water jets put in connection with the bus-bars deal with static charges on the line.

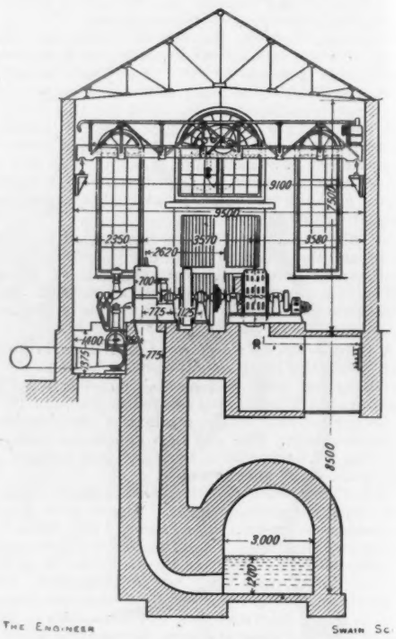



Fig. 3—CROSS SECTION OF POWER HOUSE

The overhead lines, which were constructed by Vedovelli, Priestley and Cie., are of the flexible catenary type, the conductor having a section resembling the figure eight and a sectional area of 50 square millimetres. It is supported from the catenary wire at every 3 m. by flexible droppers and clips, the catenary being supported on porcelain double bell-shaped insulators made up of two pieces, which are connected together so as to give double security. The catenary cable has a cross section of 20 square millimetres and is composed of steel galvanised wires having a breaking strength of 120 kilos. From the illustrations—Figs. 4 to 8—it will be gathered that the supporting poles are of wood. On straight portions of the line single poles are used, but on curves two poles are employed and fixed together by cross bars. Examples of the use of two-pole supports are shown in Figs. 4 and 5. The brackets are formed of two U-shaped irons and trussed to the poles. The maximum distance between supports on straight lines is 40 m.; on curves the distance is shorter. Between the rails and overhead conductor the distance is 6 m. The contact wire is, as usual, supported so that it takes up a zigzag course, the total displacement being 80 cm., or 40 cm. on each side of the centre line of the track. The object of arranging the wire in this way is, of course, to prevent grooves forming in the bows. The sag of the catenary cable varies with the distances between poles, and has been calculated so that the tensile strain is 250 kilos. at 15 deg. Cent.; the tensile strain of the copper wire is over 300 kilos. at 15 deg. Cent. All the droppers are composed of galvanised iron chains, and at the ends clips are fixed,

one of which clamps the catenary cable and the other the contact wire. On curves the copper wire is made to conform with the track by means of pull-offs, the system effectively against atmospheric discharges, there have been provided at each end of the lines, and in the middle, lightning arresters of the horn feeders, lightning arresters, and sectioning switches on the Arles section of the line, the arrangements on the other sections being similar. The feeders are

Fig. 4—ENTRANCE TO STATION

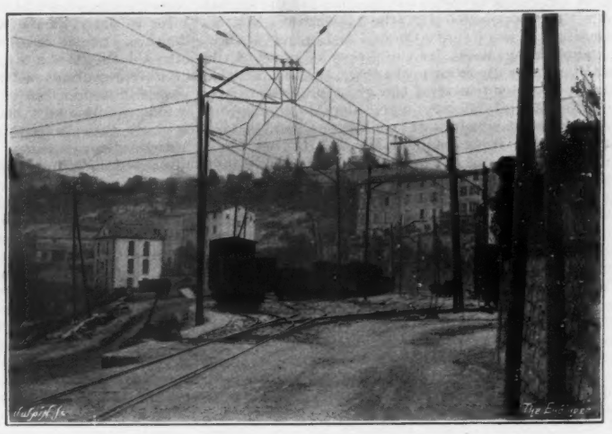
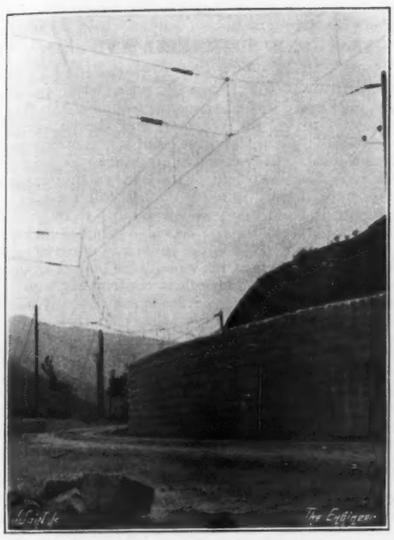
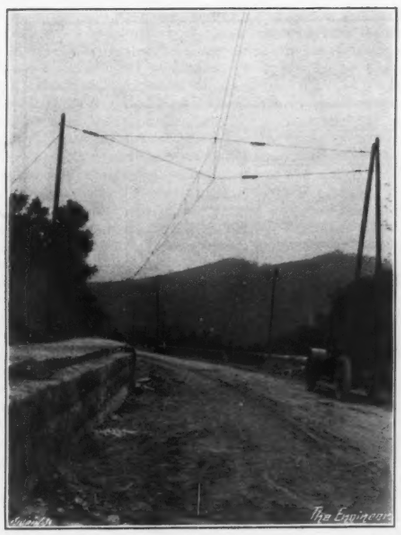


Fig. 5—OVERHEAD CONSTRUCTION AT POINTS





Figs. 6 and 7—OVERHEAD CONSTRUCTION WITH SPAN WIRES

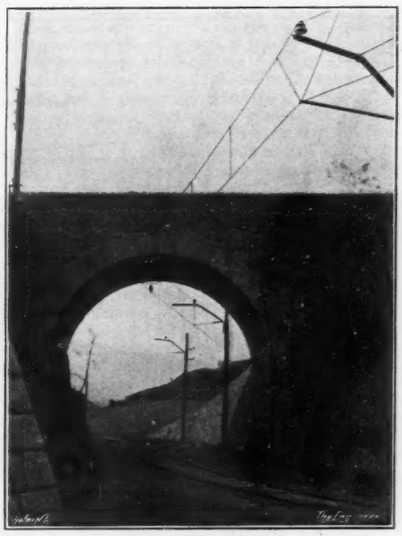


Fig. 8—ARRANGEMENT OF WIRES UNDER A BRIDGE

which are mounted on high-tension insulators fixed on the poles.

Sectioning posts, as shown in Fig. 9, have been erected at different points along the line. The method of bracing the poles together is worthy of note, as are also the section insulators, which are of the Vedovelli, Priestley's standard type and resemble those used on the Midi Railway; the same remark applies to the insulators to be seen interposed in the catenary cables on each side of the supporting bracket. Naturally, the droppers have different lengths. Wire stretchers are provided about every kilometre along the line, and it is possible to regulate the tension on the wire very easily. Joints in the catenary cable are made by splicing, whilst the copper conductor is joined by reinforced bronze ears, which are said to ensure solid binding. At certain points, as for example, on double tracks at stations and in parts of the roadway—see Figs. 6 and 7—transverse supporting wires are used. Vedovelli, Priestley's link insulators have proved exceptionally well suited for insulating the cross wires. Chains composed of these links can be made to withstand any voltage, and by using links of various sizes it is possible to secure a breaking strength of 2000 to 3000 kilos. or even more. For protection on the crossing over the river Tech, as well as at the bridge of Puyedon, hand-operated sectioning posts have been erected, but inside the town of Arles-sur-Tech an automatic sectionalising post has been erected which energises and de-energises the line automatically. A description of the Vedovelli, Priestley automatic sectioniser was published in THE ENGINEER of April 25th, 1913.

The line is fed at the Manyaques railway station, which is 1400 m. away from the generating station of Pury Redon; that is to say, at the central point of the line, by the three feeders. In the station of Manyaques a sectioning arrangement has been provided which makes it possible to insulate each of the three sections of the line, and to supply any one of them independently of the others. To protect type with a water resistance connected in series. Furthermore, a switchboard in the middle of each

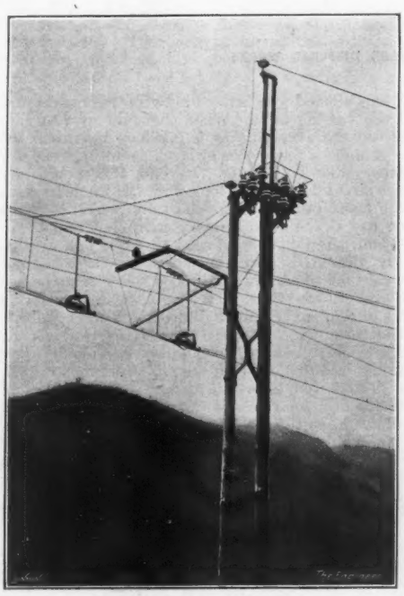


Fig. 9—SECTIONING POST

branch of the line makes it possible to localise short circuits and other faults on any part of the system. Fig. 10 shows the arrangement of composed of aluminium cables having a sectional area of 93 square millimetres. Current returns by way of the rails to a point outside the power station,

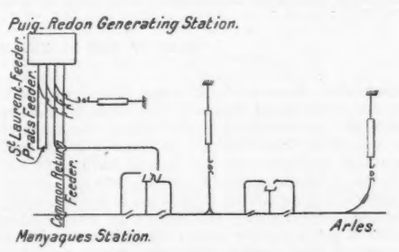



Fig. 10—FEEDER CONNECTIONS

and is finally conducted back to the generators through an aluminium cable.

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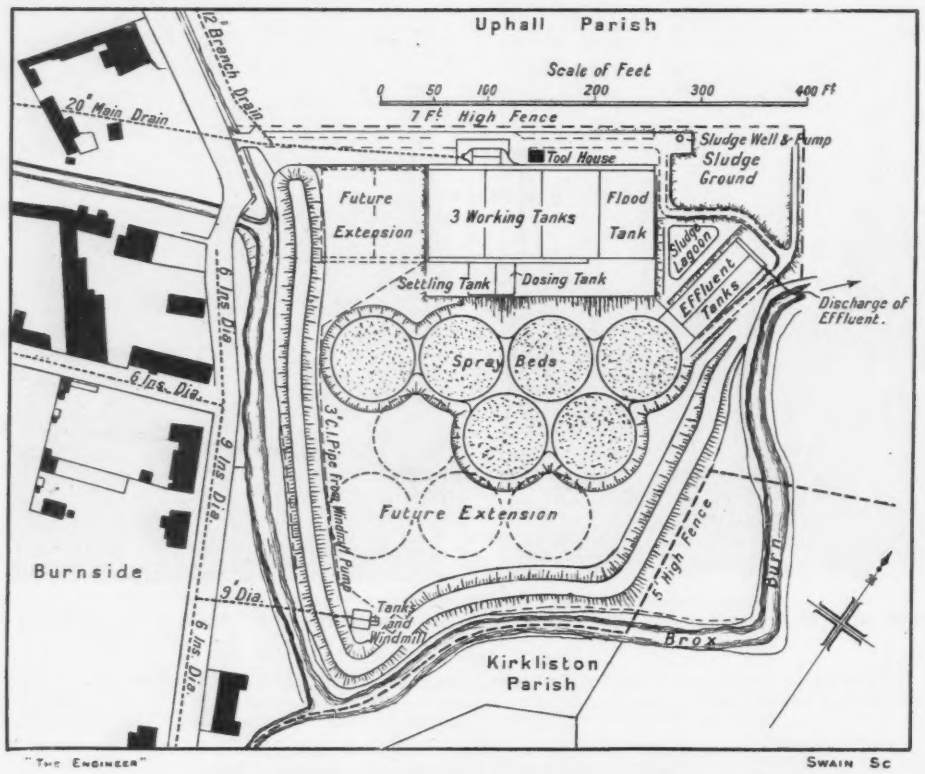
THE Central of Peru, a standard-gauge railway 249 miles long, has a section which is said to be the highest railway in the world. The line starts at Callao, on the Pacific Coast, and climbs without racks from sea level to the Galera Tunnel, pierced through the Andes at an elevation of 15,665ft. It then drops to Oroya on the eastern slope, 12,180ft. above sea level. This means that there are 106 miles of steady 4 per cent. gradient. There are sixty tunnels, thirteen switchbacks, and sixty-seven bridges, including the "Infiernillo," spanning a deep gorge between vertical faces where the train emerges from one tunnel and crosses to another opposite. From Oroya the railway runs along a river valley to Huancayo, whence it is being extended to Ayacucho to the south, and is eventually intended to be extended to meet a proposed extension of the Southern Railways from Cugio and thus form a link in the Pan-American Railway. The Central of Peru also has a Morococha branch, which crosses the Andes at a height of 15,865ft.

## NEW SEWAGE DISPOSAL WORKS AT BROXBURN.

A NEW sewage disposal works was formally put to work at Broxburn, Linlithgowshire, on April 18th last by Mr. Robert Hastie, the chairman of the special committee appointed by the Bathgate District Committee of the County Council of Linlithgowshire, to make arrangements for the proper disposal of the sewage of the Broxburn district. In this district there is now, by reason of the great progress of the Scottish shale oil industry, a considerable population. The new works, which have been designed and carried out under the supervision of Messrs. Hunter, Duff, and Middleton, civil engineers, of 17, Victoria-street, Westminster, and 42, Frederick-street, Edinburgh, are a joint undertaking for the purification of the sewage from the three special drainage districts of Broxburn, Uphall, and Dechmont, and also from the asylum at Bangour, which belongs to the Edinburgh Lunacy Board.

The sewage from these districts and from the asylum, which is gradually increasing year by year, had, up to the opening of the new works, been discharged untreated into a stream known as the Brox Burn, at various points along its course. As the asylum lies to the west of the three drainage districts, and as the course of the stream is from west to east, the asylum is the highest source of pollution. The Edinburgh Lunacy Board, therefore, having received complaints from a riparian owner, came to terms with the Bathgate District Committee to share in the purification works at Broxburn, and the population served by these works is about 12,500, of which 8000 are in Broxburn itself, 3500 in Uphall, and the remainder in Dechmont and Bangour Asylum. The main drain from Bangour is about 4 miles long. The drains in Dechmont and Uphall have been put in by the same engineers in recent years and are on the separate system. In Broxburn, however, where there are a good many old drains, a considerable amount of surface water finds its way into the drains in times of rain storms. The dry weather flow is about 30 gallons per head—or, say, a total of 375,000 gallons in twenty-four hours—and the sewage is of a domestic character.




PLAN OF THE BROXBURN SEWAGE DISPOSAL WORKS

On account of the shale workings the choice of a site for the works presented considerable difficulty; but after investigation, and with the help of the Broxburn Oil Company, a site was at length selected at East Burnside, on ground which would afford solid foundations, the underground shale workings being cut off by a large fault running east and west on a line a little to the north of the boundary fence of the site. The fall available was, however, not very great, and, as a result, the main drain had to be kept as high as possible where it enters the works and for some distance back.

The works have been designed very much upon the lines suggested in the Fifth Report of the Royal Commission on Sewage Disposal. The sewage, first of all, gravitates into either one of two detritus tanks and then flows into either one of three or into all three continuous flow working tanks. These tanks are each 80ft. long by 51ft. wide at the top and are 6ft. deep at overflow level to the flood tank, which will be referred to later. As they were constructed in solid ground the floors were sloped up to meet the central walls and each tank therefore accommodates about eight hours' flow, the three holding a full day's flow. The sewage enters and leaves these tanks through two 10in. inlet and two 10in. outlet valves respectively, these being provided with pipes to let in or to draw off the sewage or liquor at about half depth. The effluent from the tanks, first of all, flows into a deep settling tank, which has a sill round three of its sides about 66ft. long, over which the liquor passes in a thin film to a dosing tank, from which it is fed automatically through three Adams-Hydraulics syphons on to a series of six circular filter beds provided with four-arm revolving sprinklers. Each filter bed is 77ft. in diameter and 6ft. deep. The filtering medium is partly clinker from the Glasgow refuse destructor and partly whinstone. It is graduated in size from 2in. to 3in. at the bottom to from 1in. to ½in. in the upper part of the bed. The sides of the beds are of brickwork and the floors are well ventilated. When the flow of sewage is below the average the syphons cut off the supply to the filters automatically, and the supply is recommenced automatically when the tank has filled up. When the flow is above the average the syphons run continuously. The effluent from the filters runs into channels round each bed, which channels deliver into two humus tanks, the effluent from which flows over a long weir into a white enamelled brick channel, passing from thence into the Brox Burn. The sewage is of an average strength and the effluent produced is, we understand, of a highly satisfactory character, being clear, bright, and non-putrescent.

A long slotted weir is fixed between the main tanks and the settling tank. When the slots are just running full the average flow is passing, and when the weir is under a few inches of head three times the dry weather flow is passing. Beyond this point any excess liquid flows over a long weir, the whole breadth of the main tank, into a flood tank, which is of the same size as the main primary treatment tanks. In this tank the liquid is allowed to settle and is then slowly decanted into the stream. There is not sufficient fall to permit of the flood water being passed to the filter beds; but, in any case, the sewage during times of rain is very much diluted, and the condition of the Burn, even when it is receiving this sewage, which is only decanted, should be very much better than it was before the works were constructed. The slotted weir above mentioned has the effect of deferring any flood flow to the filter beds and tailing it off again, as the level in the tanks has to rise 4in. or 5in. before the slot passes three times the dry weather flow. By this arrangement a short rain storm may be dealt with without any flow passing to the flood tank.

The small fall which was available only allowed of the tops of the primary treatment tanks being brought just up to ground level, and the filter beds have had to be sunk almost wholly below this level. There was consequently a large surplus of excavated material which has been employed to form a bank, 10ft. high round three parts of the works. This bank, which is now grass grown, serves as a screen on these three sides, while on the fourth side—the north—a hedge and trees have been planted alongside an iron fence, which is 7ft. high.

Each of the primary treatment tanks as well as the flood tank can be shut off for cleaning, a sub-pipe being installed through which the sludge can be passed to a sludge pit and thence pumped either on to the ground to dry or into a sludge tank cart for disposal to farmers. The settling tank and the various supply channels can be cleaned out into a sludge lagoon.

There a few cottages at Burnside, near the site of the works, the drainage from which is at too low a level for the sewage to gravitate to the primary tanks. Small subsidiary tanks have therefore been constructed at the south-west corner of the site, and the sewage finding its way into these tanks is pumped up by windmill power into the outlet channel from the main tanks, whence it flows to the filter beds. In calm weather, when there is no wind to work the pump the liquor from this source will be irrigated on the land.

As will be seen from the plan, the site is large enough to allow of extensions of the works equal to a 66 per cent. increase on those now installed. The general contractor for the works was Mr. David Gibson, of Glasgow. The distributors and syphons formed a separate contract, which was entrusted to Adams-Hydraulics, Limited, of York. The cost the works, including half a mile of main sewer, was about £9000. On page 650 are given a series of half-tone reproductions of photographs of various parts of the works. We are indebted for these, for the plan, and for the particulars from which this article has been prepared to the courtesy of Messrs. Hunter, Duff, and Middleton.

## SEAPLANE, SUBMARINE AND SHIP.

*(By a Naval Correspondent.)*

VICE-ADMIRAL SIR PERCY SCOTT'S letter in *The Times* on Friday last on the supersession of the floating battleship by the seaplane and the submarine was certainly one of the most emphatic contributions of recent date to the extensive literature which covers the keenly discussed field of modern warship design, and is undoubtedly one that must call for careful consideration from many others besides those immediately responsible for the Naval Estimates and for deciding on the type of vessel to be laid down in each succeeding year. That his views were bound, as they have done, to excite immediate controversy may be attributed no less to their sweeping suggestiveness than to the world-wide reputation that their author has justly gained in a field so directly opposed to that which he now advocates. Sir Percy Scott's proclivities for thinking out and organising material improvements in the fighting efficiency of the Royal Navy are well known, and when a Vice-Admiral who, until very recently, was in active command of an important section of the British Navy, and whose energy and capability have undoubtedly wrought an almost unparalleled improvement in the science of gunnery, not only in the Royal Navy, but, by the example therein set, in all foreign navies as well, his views regarding the changing conditions enforced on the science of modern warfare by constant improvement in material deserve considerably more than mere perfunctory consideration. The vistas opened up by Sir Percy Scott's letter to *The Times* are very extensive, but they are, at the same time, by no means original. That they are controversial is hardly surprising, but it must be remembered that their author is one who speaks with more than usual authority. At the hands of his immediate critics he might almost be said to have suffered badly; his views have so far met, in print, with far more condemnation than leniency; but we cannot help thinking that when Sir Percy Scott, if he only will, retorts with—to use his own terms—a "simultaneous discharge" or a "rippling salvo," that some of the critics may be found sadly lacking in the detail knowledge that impelled the original article. The whole subject is one of intense interest and importance, and whatever the final verdict of the judges of the case may be, it is certain that a healthy discussion on the points raised will be of general advantage.

It must never be forgotten—and herein possibly lies the key to the inner meaning of Sir Percy Scott's views—that technical progress is extremely rapid, and that a type of battleship ordered in one financial year may be found to be seriously menaced by the numerous developments that occur during the two or three years during which she is under construction. Such a state of affairs is by no means a new one, and it has often occurred, more especially abroad, that battleships which have been over-long in the builders' yard are already semi-obsolete when completed. As time progresses it is found that technical improvements follow one another with increasing rapidity, and experience in the art of operating new inventions has a curious knack of accumulating at a far more rapid rate than is generally appreciated. Certainly this has proved to be the case in the development of the submarine and seaplane flotillas of the Royal Navy. In his original letter, Sir Percy Scott makes the extraordinary statement that "we should not be building either," referring to battleships large or small. That a serious halt in what has been an ever-increasing size of battleship since the Dreadnought was laid down in 1905 was never more forcibly shown than in the able paper on "Battleship Design," read

at the recent meeting of the Institution of Naval Architects by Mr. T. G. Owens. Therein the apparent fallacy, under existing conditions, of exceeding a displacement of 30,000 tons was clearly shown, for reasons that were lucidly stated. The influence of under-water or overhead attack were, however, ignored, though that they were present in the author's mind is hardly to be disputed. Mr. Owens pointed out, and in a manner which no other designer has done in such a scientific manner, how the ratios of weight devoted to structure, defence, and offensive power varied with increase of displacement, the latter two percentages becoming decreasingly less after a certain displacement of approximately 28,000 tons had been exceeded. No carefully reasoned exposition of this nature was adduced by Sir Percy Scott to corroborate his statements; he simply stated without attempt at proof that seaplanes and submarines have so revolutionised naval warfare that he can see no use for battleships and very little for fast cruisers. This statement, taken alone, can hardly be regarded as ultra-serious. That the development in destroyers initially gave many minds something out of the usual to think about is only what many naval men have admitted for years past; that these flotillas were so highly and efficiently organised that a daylight attack with modern torpedoes would probably result in severe losses to a battleship squadron, has been common knowledge for long enough. But that this fact should outweigh all the other considerations upon which the annual battleship programme depends has never been suggested quite so blatantly. Those who read the actual wording of Admiral Scott's article would be well advised to read also between the lines. Many of his critics immediately rushed into the fatal error of attributing a reminiscent importance to his remarks, instead of regarding them as a warning of what to expect in the near future, though perhaps the exact wording of his communication tended to convey such an idea to a greater extent than its author may have anticipated. At any rate, when the man who may justly be described as the originator and principal world's expert in target hitting—quite a different science, by the way, to ordnance manufacture—practically discards his faith in the gun for that of the torpedo tube, publicly and without loophole for subsequent evasion, one is reasonably entitled to survey the matter from every possible point of view.

Quite the most trenchant paragraph to which Sir Percy Scott subscribes is the final one in his letter, in which he states: "I do not think that the importance of submarines has been fully recognised, neither do I think that it has been realised how completely their advent has revolutionised naval warfare. In my opinion, as the motor vehicle has driven the horse from the road, so has the submarine driven the battleship from the sea." Even if this is perhaps rather a sweeping statement, it is undoubtedly one based on information to which the general public has had virtually no access. It expresses very bluntly what many naval officers have been dicussing in the last two or three years as regards the *rôle* that capital ships might be permitted to play in the face of hordes of destroyers. Twenty years ago a great deal was claimed for torpedo craft and their ability to annihilate battle squadrons. Experience, however, in the China-Japanese war, the Spanish-American war, and in the Russo-Japanese war failed to substantiate these claims. Experience of the torpedo in Chili, Brazil, China, and Japan discounted it, and these episodes are adduced in controversion of Sir Percy Scott's advocacy of the submarine, whose sole armament for purposes of destruction is the torpedo. But it can be fairly contended that the conditions are in no sense parallel, and that deductions based on past experience gained in such campaigns as these may be justly discarded in view of the immense technical progress that has since been made.

That Sir Percy Scott really advocates the entire abandonment of surface battleships and cruiser construction we do not for a moment believe. If he does, he will find few supporters. It should be noted that he did not define his contemplated submersible vessel, but we may be sure that an admiral of his experience never seriously intended his remarks to be read into a plea that the Naval Estimates of 1915–16 should contain only seaplanes and submarines. That a greater number of a much larger and improved type of submersible vessel of greater speed, power, and displacement even than the vessels of the "E" class, which have recently made the voyage from Barrow to Sydney, should be constructed in lieu possibly of two out of the four capital ships ordered each year, is, however, a possibility that requires to be taken into consideration. The entire suppression of battleships is at present unthinkable, and even the admitted risks they run by virtue of their own existence are insufficient to call for their entire suppression without vastly more plausible proof of their lack of capability to guard themselves than was evinced in Sir Percy's tirade. Submarines, whatever danger they may represent to battleships under any circumstances, cannot fulfil the battleship's *rôle*. The command of the sea may certainly be rendered easier of attainment by their employment in narrow waters, but the command of the sea involves much more than mere destruction of a hostile fleet.

The appalling danger that submarines, and we couple with them destroyer flotillas also, represent to modern battle squadrons is quite irrefutable. For the moment the point is not whether either will rule the sea to the exclusion of all else; the fact remains that in, say, the North Sea a battle squadron is subject to perfectly unjustifiable risks on the outbreak of war. Those officers who have witnessed certain experiments in destroyer attacks on fleets at sea can only endorse the view that with big modern destroyers a solitary pair of battleships or large cruisers can be rendered very unhappy. The submarine is a different species entirely. Certainly some remarkable feats in the way of attack have been performed, but it must be remembered that in peace manœuvres an attack which resulted in a destroyer colliding, with a big dent as the worst resulting damage, would have involved a lamentable loss of life had the victim been a submarine. Last year the submarines "bagged" most of the Dreadnoughts and did other extraordinary feats, but it must be remembered that they waited till the big ships came to them; it was no case of hunting them out. The submarine, however, proved an appalling menace, and no twisting the facts will get over it. We use the word menace advisedly, for although the submarine cannot fulfil the battleship's *rôle*, it may still be very deadly if it can make accurate practice with its torpedoes. To judge from the numerous critics of Sir Percy Scott's article, the evidence of the last decades, which indicates a wofully small percentage of hits to torpedoes fired, is strongly opposed to success.

Much of the force of Sir Percy Scott's argument naturally lies in the degree of accuracy with which modern torpedoes may be credited. On this point, as may not unnaturally be supposed, there is a great diversity of opinion. Historical instances are quoted as a guide to previous disappointing performances, which it is alleged will most probably be repeated. The classic instances of the sinking of the Blanco Encalada and the Ting Yuen, both ships being at anchor and not under way at the moment, are quoted; the failures of the Japanese to do more than they actually did in the torpedo attacks at Port Arthur are brought up as instances of the unreliability of torpedo attacks, and apparently it is claimed, by deduction, that the submarine will be no more efficacious when it comes to actual warfare. These arguments are, in our opinion, most speciously misleading. They entirely ignore the circumstances under which the actions were fought, or the material quality of the weapons employed, both facts of paramount importance in arriving at an accurate deduction. Indisputable facts such as are available in the cases mentioned frequently prove quite as much by negative as they do by positive evidence. Neglecting the earlier instances in which, incidentally, the effect of the torpedo explosion was to cause the total loss of the vessel struck, it must be remembered that at Port Arthur the torpedoes used were of a small 18in. type, and, though more powerful than those used at Caldera or Wei-hai-wei in 1891 and 1895, bear about as much resemblance to the modern hot-air gyroscopically controlled weapon as a cigarette does to a Corona Corona cigar for strength or length of run. The best torpedoes of to-day more nearly resemble in power the submarine mines which accounted so rapidly for the Petropavlovsk, Hatsuse and Yashima in the Japanese war, and the differences between mine and torpedo effect were a marked feature of that conflict and bore a strong influence on the subsequent increase of size of torpedoes. Ten years ago torpedo practice was not the subject of the accurate individual ship practice that it is to-day. The results of torpedo battle practice are never published, but they are well known to naval officers, and have led many to wonder how big ships may meet destroyer attacks in daylight. How to meet submarine attacks is a much more difficult problem, but one which is luckily qualified by the inability of the submarine to hunt out its quarry with the mobility possessed by the destroyer. One of the most remarkable points in Sir Percy Scott's letter is the apparent acceptance of the power of the torpedo. Most of his critics have ignored it. It is, however, impossible to doubt its probable development; even an increase to 24in. in diameter will add some 30 per cent. to a bursting charge which is already more formidable than that of a 15in. shell. The main difficulty with a torpedo lies in its speed, although modern models are capable of 30 knots up to 8000 yards and 35 up to 4000 yards range. Even so, however, they require 7½ min. and 3 min. respectively to reach their destination, and are consequently far behind the gun. At the lower range, the latter weapon might easily complete the destruction of a hostile vessel, while the torpedo was on its way. This, however, applies to large ships only. Sir Percy's argument was that submarines and seaplanes acting in concert would render the modern battleship useless—that is to say, he accepted the power of the torpedo providing it could be applied. It is by no means certain that improvements in under-water protection by means of sub-division alone are exhausted; modifications in hull construction to meet torpedo attack are one of the most important features of modern battleship design, and it seems easier to meet this peril than that of gun-fire.

That submarines have in manœuvres proved deadly efficient there is no doubt. That the vessels themselves are seaworthy and capable of an enormous range of action is proved by the recent voyage of the two "E" class boats to Australia. These vessels were 176ft. long by 22ft. wide. Is it impossible to believe in a large increase in size and power before long? Are we not on the verge of having to return to vessels of the type of H.M.S. Polyphemus, of which so much was heard and hoped and which was never repeated? The position we seem to be in is roughly this. For the moment, there is a distinct tendency, based, as Mr. Owens showed in his recent paper, on the relative proportions of weight available for armament and protection and the total displacement of the ship, to restrict battleship dimensions to, say, 26,000 tons. In the last five years the submarine has made vastly more relative progress than the destroyer, while improvement in the torpedo has been gigantic. In times of peace the submarine has shown its potentialities in a striking manner. The seaplane has been almost suddenly developed, and has undoubtedly created an entirely novel state of affairs. The immediate rapid development of these two arms is indisputable. Admiral Scott argues that the revolution is so great as to render the battleship obsolete. The answer to this is that the safety of the Empire cannot be risked for mere theories. Seaplane and submarine have yet to advance very considerably in practical reliability before they are likely to affect, let alone supersede, the floating ship. Should they develop so rapidly as to do so, their influence will be extraordinary. At the present moment, however, they cannot communicate with one another; neither possess any serious utility at night-time and in rough weather they may be utterly ignored. However dangerous they may be, singly or together, in fine weather during daylight hours, practical conditions restrict their employment in a manner that very seriously detracts from their value. Enlarge the submarine and give it something of a destroyer's capacity for night work, and then, truly, it will become a terror of the seas. Sir Percy Scott seems to imply that it already possesses such powers. Nevertheless, it is difficult to see how it can replace the large floating ship. For one thing, a large body of trained men is essential, and a submarine cannot carry them; for another, world-wide sea-keeping capacity is a *sine qua non*, yet again, the ability to engage land defences, to attack and destroy them from a distance, must be embodied in a warship design. No submarine or seaplane can fulfil these requirements. Although many years ago torpedo enthusiasts claimed that the gun was superseded, the real answer to Sir Percy Scott's letter would seem to lie in the almost basic truth that the dirigible under-water torpedo can never supplant the gun; it may be a most useful adjunct to it, and even render the chance of survival of the vessel carrying the gun a very questionable matter, but it is unthinkable that it can take its place. Meanwhile, floating ships carrying guns capable of hitting both seaplanes and submarines will continue to be built.

## DOCKYARD NOTES.

IT is stated that Greece is entering into negotiations to buy the United States battleships Idaho and Mississippi at the price of £2,345,200. The Idaho and Mississippi are sister ships of 13,000 tons, and were completed in 1905. Their main armament consists of four 12in., eight 8in., and eight 7in. guns. Their speed is 17 knots. They were designed to satisfy the "moderate dimensions" idea. They, of course, failed to satisfy anyone. And it is difficult to believe that Greece will give within a million pounds of the price named for them. They would be dear at that!

THE names of the four new battleships of the 1914–15 programme are to be:—Agincourt, to be laid down at Portsmouth; Resistance, laid down at Devonport; Repulse, to be built by the Palmer Shipbuilding Company; Renown, to be built by Fairfield Company. Agincourt will be a "Queen Elizabeth," the others of the "Royal Sovereign" class.

THE battleship Marlborough has been commissioned at Devonport. She belongs to the "Iron Duke" class. She will relieve the Collingwood as flagship of the First Battle Squadron.

THE French destroyer Magon, of 851 tons, whose trials were postponed so that several alterations might be carried out in her, has undergone a full power trial, and the success of the alterations has been shown by the fact that she made 33 knots, as against the 30 knots she was designed for. She was built at the Chantiers de Bretagne (Nantes), and has Du Temple boilers, with oil fuel.

AT the sale of obsolete battleships held by Messrs. Fuller, Horsey, Sons and Cassell at Chatham Dockyard recently the cruiser Aeolus fetched £14,850; the cruiser Perseus realised £7800; the destroyer Foam £1950: the destroyer Bruizer £1700. The cruisers Terpsichore and Prometheus and the destroyer Zebra have yet to be sold.

AS at present arranged the new Austrian Dreadnoughts will be laid down as follows:—One in August, one in October, and the other two in the spring of next year. It is calculated that the Austrian yards can build a battleship in thirty months. This may be true of the Stabilimento Tecnico and of the Monfalcone concern, but whether the Danubius Yard—which is subsidised by the Hungarian Government—is yet sufficiently complete to do so is another matter. The establishment of a fully equipped dockyard is a lengthy affair, and the fourth of the present Austrian Dreadnoughts, Svent Istfan, is considerably behind time.

## ELECTRIC CONTROL GEAR FOR SEWAGE FILTER BEDS.

AN installation in which the supply of tank effluent to filter beds is controlled automatically and electrically has recently been put to work by the Igranic Electric Company, Limited, of 147, Queen Victoria-street, E.C. The sewage plant includes eight bacteria beds, each

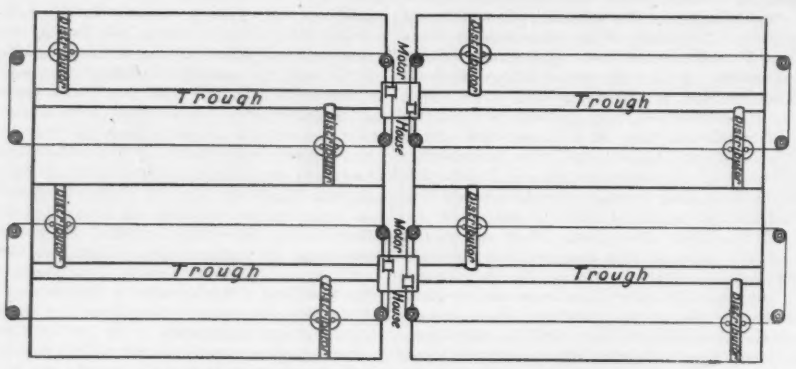



Fig. 1—ARRANGEMENT OF FILTER BEDS AND DISTRIBUTORS

rectangular in shape, arranged as shown in the accompanying drawing—Fig. 1. At the outlet end of the liquefying tanks there are two chambers, from which the tank effluent is conveyed direct to the distributor troughs by means of 15in. cast iron pipes. In each of these chambers there is a special float switch, which controls the supply of tank effluent to the distributor troughs. The distributors are arranged to work in four pairs, each pair driven by one electric motor of 3 brake horse-power on a 450-volt to 550-volt direct-current circuit. Current is taken from a tramway system, and all the motors used are identical in design and interchangeable, so that should occasion arise, repairs can be made without involving stoppage of plant. No skilled mechanic is, we understand, engaged on the work.

Each motor is arranged to be automatically started and stopped by means of an "Igranic" self-acting motor-starting switch—as shown in Fig. 2—controlled by the special float-operated switches, as shown in Fig. 3, in which the cover is swung open so as to display the internal arrangements. By means of a straight and a crossed belt, with reversing dogs, the direction of motion of the distributors is reversed each time that a pair of the latter reaches either end of its travel, and by this means the distributors are kept moving backward and forward over the beds, the motors running in one direction only. This sequence of operations is continued automatically so long

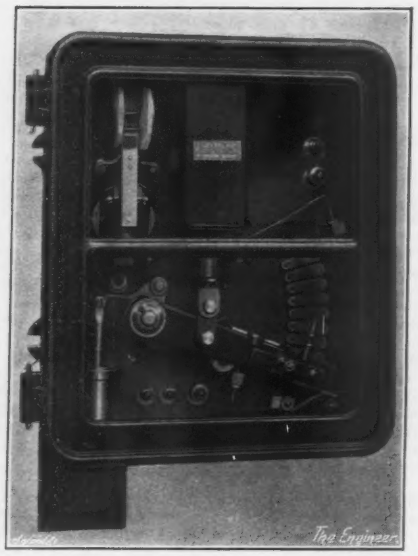


Fig. 2—SELF-ACTING MOTOR-STARTING SWITCH

as the sewage in the troughs remains above a pre-determined level. As soon as this level is reached one pair of distributors is brought into action, and each succeeding rise of 1½in. starts another pair, so that a rise of 6in. causes all four pairs of distributors to work. When it falls below that level, the distributors are automatically stopped, but not until they have reached the end of their distributing journey, and are about to reverse and commence the non-distributing journey. That is to say, the motor never stops while the distributor is actually delivering sewage on to the bed.

By means of a specially designed "Igranic" selecting switch—as Fig. 4—the distribution is equalised over all the beds, the load is equally divided between all the motors—so that no one of the motors is subjected to more wear than the others—and the maximum result is obtained from each bed. This selecting switch has four positions.

Assuming that the motors are called A B C and D, the first position of the switch would bring them into use in the order A B C D, the second would alter the order to B C D A, the third position would make it C D A B, and the fourth would produce the sequence D A B C. The next movement—in the same direction—would bring about the original order A B C D, and further movements would repeat the whole process. Out of the whole installation of controlling gear, the selecting switch is the only piece which requires to be manipulated by hand, and as this has only four positions and a rotary movement, and can only be moved in one direction, no mistake can possibly occur.

Of course, the selecting switch can be altered as frequently or as infrequently as desired. If necessary, the order of the motors can be altered once per hour, or, if preferred, it can be altered daily, weekly or monthly, but however frequently it is altered, the only operation necessary is to turn the selecting switch one notch in a clockwise direction. The automatic switchgear does the rest.

Pilot lights have been fixed on the top of each motor-

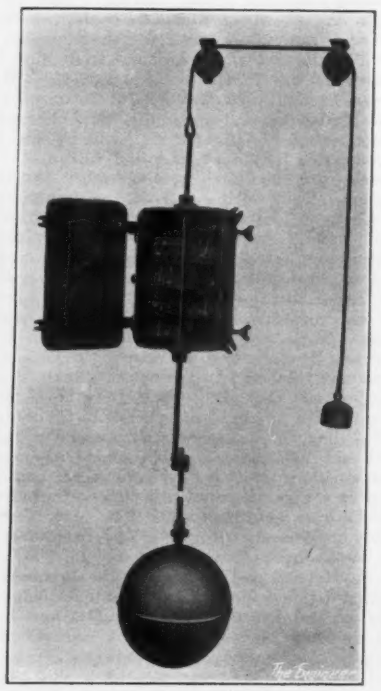


Fig. 3—FLOAT OPERATED CONTROL SWITCH

house—one for each motor—so that the man in charge of the works at night can always see from any point which beds are at work and which standing. An automatic electrical recorder is also provided in connection with the float gear to show the number of hours that each motor is actually working. The charts for this instrument will

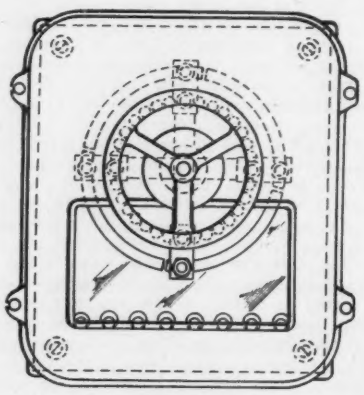


Fig 4—SELECTING SWITCH

enable the manager to work the beds uniformly and give each its required period of rest, as he can readily ascertain the quantity of sewage treated in each section.

## THE ACCIDENTS TO RAILWAY SERVANTS INQUIRY.

No. I.

THE first formal meeting of the Departmental Committee appointed to inquire into the working of the Railway Employment (Prevention of Accidents) Act, 1900, took place on Tuesday morning last. All the members—Sir William Collins (chairman), Sir Alfred Ewing, Sir Robert Turnbull, Mr. Oliver Bury, Mr. W. F. Marwood, Mr. W. Hudson, Mr. G. N. Barnes, and Mr. Stanley G. Spencer, secretary—were present.

The first witness was Lt.-Col. P. G. von Donop, R.E., chief inspecting officer of the Board of Trade, who said that the Board began investigating accidents to railway servants in 1895; the only investigations into casualties to the men prior to that were when they arose out of train accidents. In that year representations were made to the Board of Trade and two sub-inspecting officers were appointed under powers possessed by the Act of 1871. In 1900 the Act now being considered was passed as a result of the Royal Commission of 1899, and two assistant inspecting officers were appointed, and, three years later, a third sub-inspector. The same staff was in work to-day. When the staff was constituted the senior inspecting officer was made chief inspecting officer and given charge of the administration of the Act, and the senior assistant officer was made his assistant for that work.

The Act specified twelve subjects on which rules were to be made and the Board of Trade appointed a Committee under Lord James of Hereford—who had been the chairman of the Royal Commission—to draft the rules. When this was done the rules were submitted to the railway companies and to the men's unions and their objections thereto were considered by the Committee. The result was that it was decided to drop the proposed rules as to subjects Nos. 7 and 8—the position of offices and cabins near working lines and the marking of fouling points—as these could not be covered by general regulations. The remaining ten proposed rules were adopted by the Board of Trade and issued as such to the companies which objected. The draft was then sent, under Section 3 of the Act, to the Railway and Canal Commission, which, after hearing the objections, declared that Rules 2 to 10 inclusive were reasonable and, in August, 1902, they went into force.

The draft rule No. 1 dealt with brake levers on both sides of wagons, and the Railway Commission considered that its adoption might lead to difficulties in the way of the introduction of large rolling stock. A modified rule was then proposed, but the railway companies objected to it on the ground that trials showed that either-side brakes were not powerful enough. The Railway Commission therefore adjourned the proceedings for trials to be made before the Board of Trade. Such experiments were carried out at Chequerbent in April, 1904, and at Edge Hill in 1905. These experiments were made under Sub-section 2 of Section 15 and the expense was borne by the London and North-Western Company, although the Act allowed, subject to approval by the Treasury, for it to be paid out of the public funds.

In 1906 the Railway Employment (Safety Appliances) Committee was formed to examine and test appliances for the greater safety of railway servants. The original members were Sir Arthur Yorke, Mr. Richard Bell, and Sir Robert Turnbull, with Mr. Scott Main, one of the assistant inspecting officers, as secretary. In 1907 a new rule as to the either-side brake was proposed. This would have prevented the use of the Great Western—Dean-Churchward—brake, which could be applied *and* released from either side. The companies therefore took the rule to the Railway Commission, which considered it unreasonable because the Great Western brake, although it was not, in the opinion of the Commission, dangerous, was excluded. A further rule, allowing for the Great Western brake to be accepted as an alternative to a brake applied from either side, was eventually submitted and approved and came into force in November, 1911.

From 1902 to 1913 inclusive there had been 439 inspections in all, of which 190 related to tow-roping, 235 were as to lighting, 7 as to covering in point rods, 3 as to trains on the main line without brake vans, and 4 as to other matters. In 1913 there were only six inspections, of which five related to lighting.

In 1904 there were 717 inquiries into accidents to men and in 1913 there were 871. There were 313 recommendations made in 1913, of which 244 were adopted, 38 were not adopted, and 31 were outstanding. Eighty per cent. of the recommendations were adopted. Where the recommendations were not adopted it was generally proved by the companies that to do so would be unreasonable or impracticable and the object aimed at was often obtained in some other way.

After discussions between the Board of Trade and a committee of the Railway Companies' Association, standard regulations had been drafted as to the protection of men working on the permanent way; as to the movement of locomotives in sheds and sidings; the protection of carriage cleaners and repairers; and the handling of wagons without either-side brakes.

Colonel von Donop then went through the figures of fatal and non-fatal accidents in the movement and non-movement of vehicles. These we gave in THE ENGINEER of May 22nd and 29th. The increase in non-fatal accidents was considered by the Board of Trade to be due to the Order of December, 1906, as to what non-fatal accidents were to be reported. This Order had led to greater attention being paid by the companies to reporting accidents.

There had been a marked reduction in the number of fatal accidents in movement of trains down to 1912. In 1913 there was an undoubted rise, which he could not explain, unless it were due to the larger traffic. The Act did not, as a rule, deal with non-fatal accidents in non-movement cases. The increase in the latter in 1908 was due to a Home-office circular which transferred certain accidents hitherto treated under the Factory Acts to the Board of Trade. There had been increases since 1908 and witness could not account for them. The increased tonnage and larger number of passengers would contribute, but not sufficiently, and the chief conclusion he had come to was that the matter requiring the closest investigation was the number of non-fatal accidents not caused by the movement of trains.

Colonel von Donop then went through the figures as to fatal accidents in the movement of trains or vehicles, which he considered were unduly high. Shunting was necessarily, and must always be, dangerous, and nothing much could be done to make it less so. He would not, however, say that the number of accidents had reached an irreducible minimum, and he intended to persevere. The number of men killed while working on the permanent way, sidings, &c., and while walking, crossing, or standing on the line on duty ought to be capable of reduction. Special attention had been paid to the former, and Colonel von Donop recited what had been done. He felt very strongly as to the number of men killed each year in walking along the line, going to or from work. Forty deaths, on an average, occurred yearly in this way. No special precautions could be taken by the companies; it lay entirely with the men.

It was difficult to know what to do about the increase in the number of non-movement non-fatal accidents. Illustrations of typical cases were instanced. Inquiries into this class of accident were not generally held, as it was difficult to reconstruct the circumstances.

Answering Sir Alfred Ewing, Colonel von Donop said that there were three subjects on which rules might be made—the prohibition of fly-shunting, the provision of places for fire-irons on engines, and the covering in of cog-wheels on cranes. To Mr. Marwood the witness said that it would be better if the Railway Commission had power to amend any proposed rule instead of being only able to say if it be reasonable. Mr. Marwood also remarked, with reference to a point raised by Sir Alfred Ewing, that the Board of Trade had, for some years, returns as to the number of men absent through injuries for more than fourteen days.

Colonel von Donop was then questioned by Mr. Hudson, whom he informed he did not think the Board of Trade needed any further powers than it possessed. The witness did not know of a serious case where a recommendation was not adopted. He then gave several instances as illustrations of the 38 cases in 1913, where the recommendations were not adopted, and showed what was recommended, the reasons assigned in objection by the companies, and why the Board concurred. Some of these cases led to Mr. Hudson asking for further particulars, which Colonel von Donop undertook to furnish. Asked whether enough had been done by the Board of Trade, the companies and the men to reduce accidents, the witness said that he did not see what more could be done by the Board or the companies, but the men might take more care. If only ordinary care were exercised the number of accidents would be much less. It was perfectly heart-breaking to find so many mishaps due to a want of reasonable care. Several railway companies were making special efforts to get their men to use more care.

When one considered the dangers of coupling and uncoupling wagons it was perfectly wonderful how few the accidents were, and the British returns were astonishingly good when compared with those of the United States. Mr. Hudson was particularly anxious to know whether it was the case that many of the non-fatal cases should be in the fatal list owing to the men subsequently dying from their injuries, but Mr. Marwood interrupted and showed that in such an event there would have to be a coroner's inquest, and under the Act of 1871 the coroner must report the facts to the Board of Trade, and that the record would then be altered. On Mr. Hudson proceeding to say that "there was an opinion . . ." the chairman stopped him and suggested that he should get the facts from the witness and not introduce other people's opinions.

Asked as to the progress effected in reducing tow-roping, Colonel von Donop told Mr. Hudson that on some railways a very great reduction had taken place. On one very large railway it was only done at two places, and that only rarely. On another line, where in 1903 there were 288 places, there were now only 52. On many lines no tow-roping was done at all. On the other hand, on some railways there had been little reduction. Propping was done on some lines, but witness reminded Mr. Hudson that tow-roping and propping were allowed under the Prevention of Accidents Rules "where no other practical means can be provided for dealing with the traffic."

After some questions as to the powers of the Board of Trade in the matter of brake power on trains, Mr. Hudson asked the witness as to the standardisation of fittings on wagons, and Colonel von Donop replied that it would be a good thing if all fittings were standardised, and that this was one of the points kept in view in considering either-side brakes.

The witness told Mr. Bury that the outstanding feature in this matter was the increase of non-movement non-fatal accidents. The increase from 18,000 to 23,000 in five years was remarkable, but he did not think there had been this increase in the number of accidents, but that greater care was taken in reporting. Colonel von Donop hoped that witnesses from the companies or the men's unions would clear this up. He also told Mr. Barnes that he only mentioned under pressure about the guards around the cog-wheels of cranes. The Board could make a rule thereon and, if approved by the Railway Commission, it could be enforced.

Sir Robert Turnbull then took the witness through the twelve subjects named in the schedule to the Act and the following progress was reported:—(1) *Brake levers on both sides of wagons.* Done. (2) *Labelling wagons.* Done. (3) *Movement of wagons by propping and tow-roping.* Abolished by most companies. (4) *Steam or other power brakes on engines.* Universally carried out. (5) *Lighting of shunting stations and sidings.* Generally improved and companies very ready to meet requirements. (6) *Covering in of point rods and signal wires.* This rule is the least strictly complied with. It says, "where they are a source of danger," and therefore leaves some discretion. It might be strengthened. On (7) and (8) no rule was made. (9) *Protection of gauge glasses, and* (10) *arrangement of tool-boxes and water gauges.* Strictly carried out. It had never been suggested by the Board of Trade that this rule covered fire-irons. (11) *Trains without brake vans.* One case in 1912. (12) *Protection of platelayers.* Now done. The witness added that, in general, the rules were carried out strictly and the companies adopted any recommendations freely, not only after inquiry, but in cases where a complaint was made. In considering the number of accidents in shunting the increase in the number of shunters should be remembered. Colonel von Donop was not aware that some companies had already forbidden fly-shunting and had covered the cog-wheels of cranes. The only thing on a wagon that really called for uniformity was the brake lever, and this would be uniform in time.

Cross-examined by the Chairman, the witness said that the Board of Trade could make orders on any subject in addition to those named in the schedule to the Act. There had never been any necessity to go to the Railway Commission to enforce an order.

Mr. J. P. Scott Main followed, but as he was still under examination when the Commission adjourned until to-day —Friday—we will leave his evidence until our next issue.

## A PLEA FOR THE MODERN STEAM WAGON FOR INDUSTRIAL PURPOSES.

By W. M. F. R.

IT is generally believed that the petrol supply of the world will not be able to keep pace with the enormous and growing demands that now exist as fuel for internal combustion motors. The cost of petrol has risen, and will continue to rise; in the meantime, no substitute has been produced in sufficient quantity and cheap enough to take its place. It is a serious matter for the petrol motor manufacturer and the user, but it must be faced. The use of alcohol may in a measure take the place of petrol for small vehicles, but it will not come into service all at once, and it will be attended with some trouble also. In the many discussions on the oil question, no mention is ever made of the steam wagon, although there are some 4000 or 5000 of these wagons in this country alone doing excellent service on coal, coke, wood or paraffin as fuel. The extended use of other than petrol motors is an important matter. The employment of the modern steam wagon will, if used in greater numbers, remedy some of the evil effects of the petrol shortage. The twenty firms engaged in the steam vehicle industry should be urged to augment largely their output, and so reap the harvest that is now at hand. Steam has come to its own for wagons intended for industrial purposes; this is a source of satisfaction to those who believe in steam as the most reliable type of motive power for this work. Colonel Crompton recently said that there had been a regrettable tendency to disregard the use of steam vehicles, and he thought that a point to be considered was whether it would not be a good thing to encourage the use of steam for commercial road purposes.

In a paper on "Heavy Motor Vehicles," by Messrs. Geo. W. Watson and D. S. Kennedy, the following remarks are made:—"While the authors have no desire to be dogmatic as to the future development of these two sources of motive power—steam or petrol—after several years' experience of petrol and steam engines they find no reason for favouring the former in preference to steam, except in special cases. Petrol has many minor advantages, but it also possesses disadvantages. The essential requirements of a good road motor are simplicity and reliability, and in most cases it must be capable of withstanding a considerable amount of rough usage. With regard to simplicity, there can be little question that steam still holds the field; it is on the question of reliability that the petrol enthusiast raises the challenge, but he must admit certain facts at the outset. Whereas a steamer can continue to give out its full power long after it has developed a mechanical defect, a petrol machine is dependent for its full power upon the mechanism being in perfect order, as the slightest defect will at once produce a serious loss of power, which no expenditure of fuel will make good. A steamer will continue to perform its daily work with wonderful regularity, and its defects grow gradually, and do not require the same urgent attention as in the case with a petrol machine. This is a very great point to the owners."

In the early days of the steamers some of the traction engine builders looked with some disquietude at the introduction and career of the new road vehicle. The prejudice and uneasiness has passed away, and most of the best road locomotive engineers are actively engaged in the production of these self-same vehicles.

*Two Types.*—There are two main types of steam vehicles, the overtype and the undertype. The success of the overtype wagon is due to its mechanical arrangement being in accord with the traction engine design, the parts lend themselves readily to the wagon's requirements, and the details are of the well-tried types, in full view of the driver of the wagon. Most of the working parts are mounted upon a locomotive boiler, and are easily reached for oiling and adjustment. The parts are more easily cleaned. In two instances at least, the working parts of the overtype are in an oil bath, excluding dust and dirt from the parts in motion. The overtype engine is the one that is adopted in a great many cases, and is popular with users.

The advantage of the undertype wagon, with the engine arranged beneath the frame and the adoption of the vertical boiler, results in a larger platform area without increasing the overall length of the wagon, and a higher paying load in a general way. The engines usually work in an oil bath—a very necessary arrangement, seeing the engine parts are not easily accessible. This type of wagon is also largely used, and it was introduced long before the overtype wagon was evolved.

*Two Sizes.*—The wagons of both types are generally made in two sizes. The 5-ton wagon for carrying a load of 5 tons on the chassis, and a further 3 tons on a trailer mounted on steel tires for running at six miles an hour. A 3-ton wagon is made in good numbers; it is not often used for drawing a trailer, it is more often mounted on rubber tires for quick speeds. A 2-ton wagon is in demand, and can be met by two makers only. A 1½-ton wagon would be a useful size; it might be fitted with a flash type of generator, using paraffin as fuel. Mention must be made of a 6-ton wagon that is produced, capable of hauling a trailer with a 4-ton load, viz., 10 tons in all. This size can be made by some firms without the axle weight exceeding 8 tons, as laid down by the Local Government Board regulations. Rubber tires should be more generally used, but it is not advisable to haul a trailer with wagons mounted on rubber tires. The rubber-tired wagons can be run at the maximum speed allowed by the law, and give a good account of themselves.

The steam wagon is the most efficient and economical vehicle in the market if it is fitted up as follows:—A locomotive boiler working at 200 lb. pressure, fitted with a Belpaire fire-box, the boiler being made suitable for receiving a superheating apparatus in the smoke-box. By superheating the steam up to 600 deg. Fah. a great gain is effected. The prevention of cylinder condensation, combined with an increase in the volume of highly superheated steam, is tantamount to an increase in the boiler capacity; the saving in coal due to the absence of cylinder condensation amounts to 20 to 25 per cent. The saving in water by the use of superheated steam is in most cases considerably larger. A point of special importance due to superheating admits of running longer distances before taking in water. The use of superheated steam will double the water range without any other steps being taken. "A 5-ton steam wagon which, while carrying the supply of 250 gallons, runs no less than 150 miles on this tankful of water, a result not obtained without the use of a superheating apparatus."* In addition to the superheating of the steam, both the cylinders will be steam jacketed, the jackets being in direct communication with the hot steam. Piston or mushroom steam valves to be used, the piston-rods will be fitted with a good metallic packing. Forced lubrication and the use of high-flash mineral oil is essential. A feed-water heater is necessary. Given careful firing, good driving, attention to the lubrication, and the use of rubber tires, then the coal consumed per net ton-mile will not exceed 1·18 lb., while the water consumed per net ton-mile will be 8·07 lb. The steam vehicle possesses advantages of its own not found in any other wagons, some of which may be briefly named:—The flexibility of the engine gives smooth working, and prolongs the life of the rubber tires. Absence of noise and shock when speed changing. Variation of the speed and reversing are easily effected, and freedom from vibration. When necessary, the engine itself can be used as a powerful brake, the engine can be reversed while the stop valve is open—this should only be used in order to avert an accident. The steam engine is more easily understood by all mechanics. Should trouble occur, it is easily detected and rectified. The small cost of repairs is one of the valuable features, and is often referred to by users.

There is a promising future ahead of the modern steam wagon. For operation on the streets of our large towns, on the setts of the Midland counties, or in provincial districts where the roads are fairly good, the rubber-tired steamer can challenge the supremacy of the petrol-driven machines. The steam wagon is at its best for hilly districts. One of the steam wagon's advantages—being fitted with a compound engine—in the event of one engine breaking down, it is always possible to travel home on the other; breakdowns are, however, not frequent, so this advantage may not be needed.

The modern steam vehicles are made of such a strength that their durability is assured. By keeping the parts as few and as simple as possible, it has been easy to make them stronger and more fit for their work. All bearing surfaces are extra large, the crank shafts and axles are made of ample proportions, so that accidents with these details very rarely occur. Given a careful driver with a clean boiler, a steamer may be hard worked and will run for at least four years and not cost a penny for repairs. Some wagons have been worked continuously for six years without any apparent diminution of capacity and without once having been thoroughly overhauled. The few repairs after that period—beyond the tires—are sundry and unimportant, being often kept in perfect efficiency by a skilled driver. A modern steam wagon is good for ten or twelve years' hard work. Whatever the steamer may have been in the past, there is no doubt now respecting the economy of upkeep of the same, and it is, if kept in full work, a first-class investment. The running costs in actual work of the steamer do not exceed the same costs of the petrol van, as the efficiency of the steamer has been raised, and the increased cost of petrol has equalised the expenses. The writer has an exceptional opportunity of watching all the leading types of steam wagons on the roads of a wide district doing all manner of hauling in a good style.

* The distance run on the quantity of water named is taken from a paper read by Mr. D. J. Smith before the Association of Engineers-in Charge. To do this work a condenser would be required.

## THE TRIPLE-SCREW STEAMER EURIPIDES.

THE triple-screw steamer Euripides, which has been constructed by Harland and Wolff, Limited, Belfast, for Geo. Thompson and Co., Limited's Aberdeen–Australian passenger and cargo service, left the builders' hands on Saturday, June 6th, and, after satisfactory trials, proceeded to Cardiff for coaling.

The Euripides is a vessel of about 15,000 tons register, constructed under Lloyd's survey for the 100 A 1 Class, and in compliance with the requirements for the Board of Trade for passenger certificate and the Admiralty Transport Department. The new steamer is generally in design and style similar to the Demosthenes, built for the same line in 1911, but is of larger dimensions, being 569ft. 9in. in length overall, 67ft. 4½in. extreme beam, and with a displacement of about 24,500 tons. The double bottom extends right fore and aft, and there are 11 water-tight bulkheads carried up to the awning deck. These, in conjunction with the seven steel decks, the massive beams, and shell plating, form a structure of great rigidity.

The new vessel has large cargo capacity and excellent facilities for the speedy handling of goods of every description. There are 19 steam winches working seven cargo hatches, at which powerful electric lights are provided, so that working can be carried on by night as well as by day. Nos. 1, 2 and 3 compartments are insulated for the carriage of frozen cargo, and, in addition, the upper and lower 'tween decks in No. 2 compartment and all decks and holds in No. 3 compartment have air trunks fitted to enable fruit to be carried in these compartments. The vessel has two steel pole masts, and is fore and aft schooner rigged. There are 20 cargo derricks. The steering gear is of Harland and Wolff's type, and is controlled by telemotor from the navigating bridge. As usual with the Aberdeen liners, two classes only will be carried—first and third. The first-class dining saloon is on the main deck forward, and extends right across the ship. It is designed to seat

112 passengers. The first-class smoke-room is on the boat deck, and has large brass sliding windows, in pairs, with stained glass shutters and jalousies. The first-class library and lounge is on the bridge deck. This compartment has parquetry flooring, and has large brass windows, arranged in pairs, with stained glass and jalousie shutters, and is divided in two by a glass screen. There is also a gymnasium on the boat deck. The state-rooms are situated on the bridge and awning decks, and have either two or three berths each. Cot beds are fitted to eight rooms on the awning deck, and one room can be converted into a sitting-room. Each room is fitted with a single or double folding lavatory, wardrobe, &c. A large number of the rooms on the bridge deck are intercommunicable. On the awning deck the rooms are arranged on the tandem principle, giving natural light and ventilation to each. All the cabins are of considerable height, those on the awning deck being 8ft. 9in. and those on the bridge deck 9ft. Every cabin has a port-hole to itself.

Like the other vessels of the line, the Euripides has very superior accommodation for third-class passengers. The third-class dining saloon on the main deck will seat 274 persons. The smoke-room is on the awning deck. There is also a general room, which is similar to the smoke-room. The third-class permanent state-rooms are situated on the main and awning decks aft, and consist of two, four, and six-berth rooms. Each room is fitted with a wash basin, &c. Portable third-class accommodation is provided aft of the permanent rooms on the main deck, and consists of two, four, six, and eight-berth rooms.

The captain's, officers', and engineers' accommodation is well arranged, and the doctor's room and surgery is conveniently situated for both first and third-class passengers. There is a barber's shop for the first-class passengers at the after end of the awning deck, and, generally speaking, every possible measure has been devised for the welfare of both passengers and crew. A laundry is provided on the bridge deck forward. Special attention has been given to the question of ventilation, both natural and mechanical systems being employed. Lifeboat accommodation for all on board is carried, while the vessel has a complete installation of electric light, and is also fitted with wireless telegraphy and submarine signalling apparatus.

As already indicated, the Euripides is a triple-screw steamer, having two sets of reciprocating engines driving the wing propellers and a low-pressure turbine driving the centre propeller. The vessel has also an emergency lighting set driven by a Diesel engine situated on the boat deck.

## LETTERS TO THE EDITOR.

*We do not hold ourselves responsible for the opinions of our Correspondents.)*

### LONDON, BRIGHTON AND SOUTH COAST RAILWAY LOCOMOTIVES.

SIR,—With reference to the paragraph in THE ENGINEER of May 15th (page 546) concerning the new London, Brighton and South Coast "Baltic" type tank engine, No. 327, Charles C. Macrae, I should like to point out that the longest non-stop run which these engines can be called upon to perform would be London–Portsmouth (87 miles)*, but this is not, as your paragraph implies, actually scheduled, though very possibly in contemplation. The 106 min. timing you refer to (= 49.2 miles per hour) is, of course, that given to the "crack" 11.35 a.m. ex Victoria—never a heavy train—between Clapham Junction and Fratton (81¼ miles), which gives a rather different average of 46.3 miles per hour.

In the matter of railway facilities Portsmouth was until recently very far behind other towns of its size—thanks largely to the pooling agreement between the two companies—but a few years ago the London and South-Western Railway took the initiative by introducing a dining car service of three trains in each direction, contemporaneously with some much-needed accelerations. From time to time also there have been rumours of a Pullman car service by the rival route, and I have particulars, unfortunately not accessible at the moment of writing, of a special non-stop run from Victoria to Portsmouth *viâ* Dorking, made about two years ago, a complete train of Pullmans doing the distance, if memory serves me, in 110 minutes.†

Even in view of such possible developments as this, it is difficult for the onlooker, however much he may admire the latest addition to the Brighton "stud," quite to grasp the *raison d'être* of such a powerful machine as the new "Baltic" tank. Its justification lies no doubt in the fact that the 4–4–2 tanks are unable to accomplish the longer non-stop runs from lack of water, troughs being of course unknown on the London, Brighton and South Coast Railway, as they are, with still less reason, on the neighbouring London and South-Western Railway, and the "Baltic" type offers a maximum of bunker and water capacity without the deadweight of a tender, the weight of coal, &c., in the case of a tank engine being, of course, available for adhesion. At the same time it is a little surprising that, with their large stud of tender engines, it should so soon be expedient to launch out into this entirely new type, although of course it must be recognised as the natural development of the "Pacific" type, which has only recently been introduced on this very line.

Undoubtedly the Portsmouth road, with its numerous slacks—four severe ones in the first 40 miles out of Victoria *viâ* Dorking—and heavy gradients, often worse than 1 in 100, must be reckoned as a very hard one, worse even than the better known London and South-Western Railway direct Portsmouth line. At the same time, the banks are mostly short, and there is much "give-and-take" in both directions. Personally I have always, found the existing types fully capable of maintaining any schedule at present in force on the Portsmouth section. In fact, first-class locomotive work is only demanded for a few weeks at the height of the season—this being a favourite route to the Isle of Wight—as in winter loads and schedules are both rather mediocre, and in summer the fastest trains, both from London Bridge and Victoria, only load moderately—the hardest trains to work are undoubtedly the less tightly timed, but far heavier, trains, such as the 1.50 p.m. ex Portsmouth, frequently even to-day worked by Stroudley 0–4–2's, which convey (to and from Sutton) Victoria and City portions.

It will be recalled that (old) No. 326, "Grosvenor," the famous single-wheeler, was built specially for service on the Portsmouth road. The Stroudley 0–4–2's were a peculiarly unsuitable looking type for this road, and have largely been superseded by the successive bogie types "Rosebery," "Bessemer," "Sirdar," and finally by the fine "Atlantics;" but even to-day the "Gladstones" are not unknown on the heavier, but less fast, trains and on the subsidiary Brighton *viâ* Horsham service. The bogie seems to have been recognised as specially desirable on this road, as the No. 201, "Rosebery" class, was the first leading bogie type on the London, Brighton and South Coast Railway, and was specially built for the Portsmouth service. It may be of interest to note that the original Charles C. Macrae (No. 314) was one of this batch, and is, of course, still in service, but in common with most Brighton engines is now recognisable only by its number.

I had purposed giving details of one or two trips picked at random from a somewhat extensive repertoire of runs made on the Mid-Sussex route, but I fear I have already trespassed rather far on the space available for correspondents. Suffice it, therefore, to say that on almost every occasion, with various classes of engines, I have found the only difficulty the drivers had to face was how to kill time. Nor is this remarkable in view of the loads, and the engines are, in fact, seldom pressed at all on the up-hill sections, all of which clearly indicates that the existing types are fully able to cope with the present demands of the traffic department as to loads and speed, usually with a substantial margin. It only remains to see what increased demands the new "Baltic" tank is designed to meet, and this all who follow the policy and progress of this go-ahead "little" line will await with interest.

G. CULLIS.

London, June 2nd.

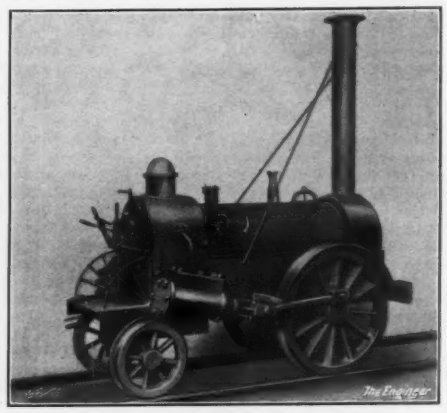
* The actual distances from London to Portsmouth, which are seldom correctly stated, are as follow from Victoria, whence all the fastest trains run:—

| | Miles. | Chs. |
|---|---|---|
| Victoria to Portsmouth Town *vid* Mitcham Junction and Sutton | 85 | 16 |
| Victoria to Portsmouth Town *vid* West Croydon and Sutton | 87 | 39 |
| Victoria to Portsmouth Town *vid* Three Bridges | 85 | 63 |

† In glancing at the train alterations for June I find the London, Brighton and South Coast Railway is running a Pullman car on one train in each direction from 8th inst. This, however, is far from being the same thing as a complete train of Pullmans, which would imply a load of 300–400 tons. I also notice in your current issue—page 592, report on the proceedings of the Royal Commission—that the unsatisfactory service to Portsmouth is again being agitated. Needless to say, to those who know the road the comparison with the best Bournemouth trains is quite unfair—which is not to say that the Portsmouth service of to-day is all it ought to be. It is not.

### THE NORTHUMBRIAN LOCOMOTIVE.

SIR,—It may be objected that it is not engineering to make models, but the late Mr. Webb, of the North-Western Railway, made about twenty years ago a model of the Rocket. Antiquarians and architects make models of buildings and of old temples of antiquity. Naturalists make "restorations" of the extinct animals of a past age. Therefore an engineer may be excused for making a "restoration" of an early locomotive that was broken up probably nearly eighty years ago. The model is not a working one, but fairly represents the old engine. It is taken from three sources: the drawing of the late Mr. James Nasmyth, as given in THE ENGINEER some years ago—which engine was mistaken by him for the Rocket—also from a drawing in Henry Booth's "History of the Liverpool and Manchester Railway" and from some fragmentary sketches of Messrs. Stephenson's in South Kensington Museum. The maker thought that a model would convey to the public a better idea of what the old engine was like than a drawing would, and he gathers from those who have already seen it that such



**MODEL OF THE NORTHUMBRIAN**

is the case. The model, of course, is not accurate in all respects. Whether the wheels were wood or iron is not certain, but probably the former. Mr. Nicholas Wood in his treatise on railways gives the following particulars:—Cylinders, 11in. by 16in. stroke; driving wheels, 5ft.; weight, 6 tons 3 cwt.; diameter of boiler, 3ft.—3ft. 3in.?—6ft. 6in. in length; 132 tubes, 1¼ diameter; total heating surface, about 411 square feet.

After the unfortunate accident to Mr. Huskinson, the engine with one light carriage conveyed the injured man to Eccles, attaining during part of the journey a speed of 35 miles an hour. It was in use on the L. and M. Railway till about 1835.

Farnham, June 8th. JOHN HENRY KNIGHT.

### SURFACE COMBUSTION.

SIR,—Will you allow us to reply to the letter of Mr. Alleyne Reynolds which appeared in your issue of May 29th, calling in question the accuracy of the temperatures stated to be obtainable in our surface combustion process?

The data relating to the specific heats of gases on which Mr. Reynolds bases his criticism are entirely inaccurate if they lead him to the conclusion that the temperature limit obtainable with cold air and cold coal gas is about 1600 deg. Cent. For many years the specific heats of gases were very inexactly known, and deductions concerning calorific intensity led to the wildest results, temperatures of the order of 3000 deg. Cent. being indicated as practicable. This constituted a most serious disagreement between theory and practice, a disagreement which was only removed by the more accurate determinations of specific heats carried out by Mallard and Le Chatelier. The importance of the determinations made by these two physicists can scarcely be exaggerated. They introduced order and precision into a field where previously chaos had reigned, and for the first time rendered really practicable calculations of calorific intensity.

We welcome the letter of Mr. Reynolds because it gives us the opportunity of directing attention to the work of Mallard and Le Chatelier, which deserves to be much more widely known than it is. Mr. Reynolds does not state the values for specific heat which lead him to his conclusion. We have every reason to doubt their accuracy. The values obtained by Mallard and Le Chatelier are as follows:—

For nitrogen, oxygen, hydrogen, carbon monoxide and other di-atomic gases, $S = 0.303 + 0.000054t$.

For carbon dioxide, $S = 0.37 + 0.00044t$.

For water vapour, $S = 0.34 + 0.00030t$.

"S" being the number of calories (kilogramme calories) required to raise 1 cubic metre N.T.P. of the gas 1 deg. Cent., and "$t$" being the temperature of the gas in degrees Centigrade. It will be noticed that in each case the specific heat of the gas increases as the temperature of the gas increases.

If Mr. Reynolds will re-calculate with the aid of these specific heats the calorific intensity of coal gas he will find that it is in the neighbourhood of 1900 deg. Cent., which is closely in agreement with the temperature which we claim to obtain in practice. In fact, the temperatures which we have measured in surface combustion furnaces confirm in a most encouraging manner the specific heat values, even over a range of extremely high temperatures, given by Mallard and Le Chatelier.

The agreement is not limited to coal gas, but has been found to obtain also in the case of Mond gas. It would probably surprise Mr. Reynolds to know that, burning cold Mond gas with cold air, we have obtained a temperature of 1508 deg. Cent. Calculation from the specific heat values of Mallard and Le Chatelier indicates that the theoretically obtainable temperature is in the neighbourhood of 1490 deg. Cent. Here, again, we have a very close agreement between theory and practice.

By way of confirming the high temperatures which we claim to produce with cold air and cold coal gas we may mention that we can melt platinum and can make pure china-clay run like treacle. We can also fuse pure quartz into a glassy mass. This in itself is sufficient proof that the temperature produced is considerably in excess of Mr. Reynolds' 1600 deg. Cent. By melting tests on various materials of known melting point, we have established the temperature produced as being in the neighbourhood of 1950 deg. Cent.

The question of keeping the temperatures down to the limits imposed by the refractories of commerce has been already dealt with in your articles.

(For BONECOURT SURFACE COMBUSTION, LIMITED),
G. W. DAMAN, Secretary.

London, June 9th,

SIR,—Like many others, I have followed with much interest the development of the Bonecourt surface combustion process, and have had a great admiration for the patient manner in which this has been developed. I think, however, that articles so optimistic in tone as that in your issue of the 29th ult. are liable to misconception by the average steam user.

The trials described in that article are only, after all, very little removed from the laboratory stage, as an apparatus which gives a good efficiency at such low ratings as 36 lb. of oil per burner per hour has a long way to go before satisfying the actual conditions on such craft as battleships and torpedo destroyers. The particulars given on page 586 are not sufficiently complete for an outsider to make a reliable heat balance, there being no indication as to whether any dryness factor was taken for the steam, nor are the constituents of the oil given. Presumably 17,800 B.Th.Us. is the value of the oil after making full deductions for the hydrogen; but, if so, then it is lower than the average oil in my experience. Of course, any error in this value would affect the efficiency, whilst not disturbing the actual evaporation per hour of oil, this being given at 17 lb. It is to be noted, however, that this evaporation includes the economiser; so that, making allowance for the small scale of the experiment, the evaporation is not much better, if any, than other recorded results.

That portion of the article dealing with solid fuel is, however, very much more seriously misleading than the earlier portion. There is nothing whatever to show the nature of the fuel, and the man in the street, when he talks of solid fuel, has visions of coal or coke. The poor station superintendent who has to deal with a committee will have some difficulty in explaining why it is that he has been bragging about an evaporation of 10 lb. or 12 lb. from and at per pound of coal, when apparently 17.8 lb. evaporation is quite possible. That it is an impossibility with any solid fuels which are available is easily shown by a simple calculation. Assuming 100 per cent. efficiency for the furnace, 17.8 lb. evaporation would call for a fuel having 17,200 B.Th.U. per pound. As pure carbon is usually reckoned at round about 15,000 B.Th.U. the inference is obvious. Whether or not the solid fuel used takes some form of solid paraffin does not affect the question, as with the present sources of supply that is a long way from being a commerical possibility.

H. CAMERON.

Glasgow, June 5th.

### SIR JOSEPH SWAN.

SIR,—Some few days ago I was sorry to see that my old master and friend, Sir Joseph Wilson Swan, left this life of ours. I felt it as a personal loss, though years have passed since I had the honour of serving him. A bright, clean intellect, coupled with the power of doing, went to the grave with him. I knew him. In the Norse spirit, let me cite Havamal:

"Man dies,
Earth dies.
But one thing never dies,
Judgment of the dead!"

His judgment will be that he did his duty, and England ought to be proud of this grand old man, who carried out the dictum of the Almighty: *Fiat lux.*

JOHN RHODIN.

June, 1914.

## EDUCATIONAL INTELLIGENCE.

A HEATING STUDENTSHIP tenable in the Faculty of Engineering of University College, London, of the value of £50 a year, together with £11 11s., being the amount of College fees, may be awarded by the Institution of Heating and Ventilating Engineers in July. The student will be required to devote his whole time to research work in heating and ventilating engineering. Further particulars can be obtained from the Secretary of University College, to whom application should be made on or before Saturday, June 20th.

THE first course of lectures in town planning to be given in the University of London will take place in August, when a summer school of town planning will be held from the 3rd to the 15th. The lectures will be given at the new School of Architecture at University College. This building is the largest and most complete of its kind in the United Kingdom, and it is intended to use some of the rooms at an early date for a department of town planning. Mr. Herbert Samuel, President of the Local Government Board, has accepted the office of President of the School. Copies of the syllabus can be obtained from Mr. J. S. Rathbone, joint hon. secretary, Fitzalan House, Finchley.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on June 8th, the Duke of Northumberland, President, in the chair. Mr. H. B. Hans Hamilton, Sir William H. Lever, Bart., Mr. Percy St. C. Matthey, J.P., Mr. H. W. P. Matthey, Miss Matthey, Mr. J. F. C. Snell, and Mr. T. J. Taylor were elected members. The chairman reported the decease of Sir Francis Laking and Sir Joseph Swan, members of the Institution, and resolutions of condolence with the families were passed. The Secretary announced that the President had nominated the following gentlemen as vice-presidents for the ensuing year:—Lord Blyth, Mr. J. H. Balfour-Browne, Mr. Charles Hawksley, Dr. Donald Hood, Lord Moulton, Mr. E. Pollock, Sir James Crichton-Browne (Treasurer), and Mr. Alexander Siemens (Secretary).

## RAILWAY MATTERS.

WE learn from a contemporary that the articles of association of the Beira-Zambesi Railway Company in Brussels have been sent to Lisbon for the approval of the Portuguese Government. As soon as this has been obtained the company will be formed and construction of the line commenced.

TWO directors of the Lacroze Tramways Company, Drs. Miguel and Teofilo Lacroze, left on April 10th on a visit to Europe and America to study the underground railways and electric tramways systems, in connection with the proposals of the Lacroze Company to extend its system. A short stay will be made in London, in order to study the financial side of the subject, and a visit will be paid to the Panama Exhibition, at San Francisco, where the exhibits will comprise many examples of tramway construction. The directors will return to Buenos Aires towards the end of 1915, when the extensions will be commenced.

THE use of exhaust steam for operating turbine devices utilised for various purposes on locomotives is well known, but according to the *Railway News* a curious arrangement has been devised by a French engineer. The blast pipe is connected to the casing of a turbine mounted upon it in the smoke-box, and the turbine drives a fan situated at the base of the chimney. The wheel of the turbine is provided with two sets of blades between which are arranged fixed blades carried by the casing. The wheel is fixed to a tubular shaft carrying the fan and supported and guided by a pivot and ring of balls. The exhaust, after passing through the turbine, escapes by a pipe extending sideways from the casing into the smoke-box.

WORK is well in hand with the electrification of the London and South-Western suburban system, and it is hoped that trains will be running over certain routes before the end of the year. The following times are given by the *Railway News* as representing the duration of journey by stopping trains, under the new conditions, from Waterloo to various suburban stations :—Earlsfield, 12½ min.; Wimbledon, 16 min.; Raynes Park, 19½ min.; Malden, 22 min.; Norbiton, 25½ min.; Kingston, 27½ min.; Putney, 14½ min; Barnes, 17½ min.; Mortlake, 20½ min.; Richmond, 24½ min.; Twickenham, 29 min.; Shepperton, 45 min.; Fulwell, 34 min. All these stations are associated with the Kingston "circle" route, so that facilities either way will apply.

HIS MAJESTY'S Consul-General at Seoul, Mr. A. H. Lay, in his report on the trade of Corea in 1913, states that during the year the Corean railways carried 4,143,803 passengers and 1,425,246 tons of goods, an increase, as compared with 1912, of 1,695,075 passengers and 293,474 tons of goods. The Seoul-Gensan line is expected to be finished towards the end of this year. No light railway was constructed in 1913. Starting from the financial year 1914-15, the third railway programme is to be undertaken. This includes the reconstruction of the Seoul-Fusan line, which was originally built in a hurry owing to the exigencies of the time, and which, though since then to some extent improved, requires reduction in gradients, &c. A continuation of the Seoul-Gensan line from Gensan to Yong-heung, 34 miles in length, passing through Munchon and Kowon, is also to be laid down later, and the extension is to be carried on to Hamheung.

A VERY valuable officer to a railway company, states the *Railway Gazette*, is its chemist. The extent and value of his duties are, however, known to but few and are, possibly, appreciated by still fewer. It is difficult to compress into a short paragraph any idea of the multifarious services a railway chemist has to perform. He may have, for instance, to ascertain the calorific value of coal or mineral oil, the viscosity of lubricating oil or wagon grease, or the analysis of some water. The railway chemist has often to play the part of metallurgist and be called upon to express an opinion, after a microscopical examination, as to the composition of a piece of metal, and as to the causes of its failure. The storekeeper may perhaps have his doubt as to the reasonableness for paying a high price for some patented paint, oil, or composition demanded by the civil or mechanical engineer, and he would then call in the chemist's assistance to see where the virtue of the speciality lay and whether the desired end could not be attained by less expensive means. Then the chemist often furnishes a table of the necessary ingredients by which the company is enabled to make certain materials instead of having to buy them or to suggest ways by which waste liquids, scrap metal, &c., may be turned to good account. It will thus be seen that the railway chemist may be a very valuable officer.

ON Wednesday last consideration was begun at Westminster, by a Select Committee of the House of Commons, under the chairmanship of Mr. Clancy, of a Bill which has as its object the increase of through communication by railway with all districts of London. The measure is promoted by the Great Northern and Metropolitan Railway Companies. Mr. Balfour Browne, K.C., in reply to the chairman, said one of the objects of the Bill was to enable the Great Northern Company and the Metropolitan Company to become joint owners of the Great Northern and City Tube, and to exercise the powers obtained last year to construct an extension from Moorgate-street southwards to Lothbury. Further, authority was asked to make an underground line from Lothbury to the commencement of the City and Waterloo Railway, near the Bank. This would improve communication with the south of the Thames. It was also proposed to make an underground line from the Great Northern and City Tube, north of Moorgate-street, to the Inner Circle, near Aldgate, which would give additional travelling facilities not only between the City and East London, but round the whole of the Inner Circle and all the south-eastern parts of the Metropolitan Railway, by way of the old Thames Tunnel. Another proposal of the Bill was the construction of two short lines by the Great Northern Company between Finsbury Park Station and Drayton Park Station, on the Great Northern Tube, so that it would be possible to run trains from the underground line to the level of the Great Northern open-air station.

## NOTES AND MEMORANDA.

ACCORDING to *African Engineering*, a French scientist has discovered that the presence of radium on the point of a lightning conductor increases the electrical conductivity of the surrounding atmosphere enormously, and generally enables atmospheric charges to be conducted away harmlessly without any lightning flash.

THE port of Tripoli is beginning to wake up from its sleep of centuries, and the returns, just published, for 1913 show the arrival during the year of 1502 vessels with a total net tonnage of 804,178. Merchandise was disembarked to the tune of 204,414 tons, while 29,715 passengers were landed. The outward-bound ships were 1493 in number for 819,263 tons, and carried away 23,324 passengers and 33,832 tons of goods. The export and import total was therefore 238,246 tons of goods and 53,039 passengers, of which 125,077 tons and 49,796 passengers were carried in Italian bottoms.

IN a paper recently issued by the United States Bureau of Standards, the results are given of an investigation of eight flow calorimeters, representing types widely used. The investigation has shown that several of the calorimeters could be used, when proper precautions were observed and suitable corrections applied, to determine the total heating values of gases to an accuracy of about 0·3 per cent. Some calorimeters are, however, subject to errors that cannot be eliminated except by comparison with a standard instrument, such errors for one calorimeter amounting to nearly 2 per cent. Examination of a very large amount of data indicates that with these calorimeters, free from significant errors, values should be determinable to an accuracy of the order of 1 per cent.

A SUGGESTION was made by Mr. W. A. D. Rudge in a recent issue of *Nature* that a possible cause of explosions in coal mines lay in the fact that a cloud of coal dust when projected against an insulated conductor might give rise to sparks several centimetres in length. Experiments in the laboratory with various kinds of dust had shown that the potentials might easily rise high enough to make this possible. During tests made in Ludlow Pit at Radstock with a Wulf electrometer provided with a radium-tipped collector, potentials of 280 volts or more were observed behind a train of wagons, but no sparks were noticed. It should be pointed out, however, that the coal dust in mines is rarely pure, and that coal dust mixed with stone dust did not give rise to a high charge; as the sign of the charge depended on the dust material, and coal dust and stone dust imparted opposite charges to the conductor, the mixture was comparatively harmless. These results seem to supply a strong argument in favour of the use of stone dusting in coal mines.

THE new generating station now under construction for the Philadelphia Electric Company will, according to the *Electrician*, contain the largest generating set yet built anywhere. The complete generating plant will consist of only two turbo-alternators. One will be a 30,000 kilowatt 13,200-volt 25-cycle three-phase set, and the other a 35,000-kilowatt 13,200-volt 60-cycle three phase set. The 35,000-kilowatt machine is 63ft. long, 21ft. wide, and 16ft. high. Complete with generator and exciter it will weigh 600 tons. The turbine is a Curtis 13-stage machine working at 215 lb. pressure and 150 deg. Fah. superheat. It will exhaust into a 50,000 square feet surface condenser of novel design. The alternator has been designed to have an output of 1460 ampères at full load at a power factor of 0.9. The armature has an internal reactance amounting to 10 per cent. The six rotating magnet poles are driven at 1200 revolutions per minute, and on the same shaft is a 150-kilowatt 250-volt 600-ampère shunt-wound exciter. The armature is provided with thermo-couples connected to indicating instruments to give warning of excessive temperatures in the machine.

AT the Royal Society recently, Mr. E. E. Fournier d'Albe, D.Sc., read a paper—communicated by Sir Oliver Lodge, F.R.S.—on "A Type-reading Optophone," an instrument for translating the action of rays of light into sound, and so making light recognisable by means of the ear. The apparatus, which thus transforms visual impressions, is intended to enable totally blind persons to "read" the type of ordinary printed letterpress. It consists essentially of a rapidly rotating disc, perforated, like a siren disc, with several concentric circles of holes. A Nernst electric lamp is placed behind the disc, with its filament stretched radially across the circles. The light, shining through the holes, gives regularly recurring flashes, which, when of suitable frequency, can be detected by means of the chemical substance selenium and a telephone. An image of this line of intermittently luminous dots is thrown upon the type to be read, and the light diffusely reflected from the type is received on a selenium bridge. Type 5 mm. high can be thus read by means of an ordinary high-resistance telephone receiver. The effect becomes rapidly fainter as the type diminishes in size; but ordinary newspaper type is readable with the help of a highly sensitive Brown telephone relay.

WE learn from the *Electrician* that an electrically operated refuse disposal plant, recently constructed in San Francisco, converts refuse of vegetable or animal composition into useful commercial products. Grease is extracted and sold, while the bones and vegetable parts are made into fertilisers. All operations in the plant from the time the refuse is received until the converted product is shipped away are performed by individual motor-driven apparatus. Refuse is collected at night in 5-ton enclosed tank motor trucks. On arriving at the plant the tanks, which are detachable, are hoisted to the top of the building by a motor-driven crane and dumped into steam-jacketed closed tanks, where the refuse is boiled for five hours. The mass is then compressed to extract the water and oil, which are afterward separated from each other by skimming. To drive off the remaining moisture in the solid matter it is fed through rotating boilers by helical screws. From the boiler the mass is transferred on a conveyor to tanks containing petrol, which absorbs all the remaining oil and grease. By distilling the solution in a small refinery, the petrol is afterwards reclaimed and used over again. The dried material, after being passed under powerful electro-magnets to remove any nails or can covers, is pulverised and mixed with chemicals, making a valuable fertiliser.

## MISCELLANEA.

THE Home Secretary notifies that pursuant to Sec. 80 of the Factory and Workshop Act, 1901, he has certified the process of casting iron or steel to be dangerous, and that he proposes to make regulations to apply to all factories and workshops or parts thereof in which such process is carried on. The proposed regulations do not apply to the casting of pig iron from blast furnaces or to the casting of steel ingots.

IN connection with a large electric power scheme in the province of Groningen, where a large power-house is being established, from which power will be distributed over a large area through about fifty sub-stations, an exhibition is to be held at Helpman-Groningen in August and September next, where the applications of electricity to agriculture and small industries, as well as in the home, is to be demonstrated.

WE learn from *Electrical Engineering* that it has been decided to start a service of electrically driven barges on the river Hudson next autumn. The boats, which will be 276ft. long, beam 40ft., with a deep-loaded draught of 6ft., will be fitted with a turbo-generator, which will supply power to three 75 horse-power motors, which will be direct coupled to three propellers. It has been calculated that the cost of carriage with these barges will work out to about 10d. per ton, as against 3s. per ton when a steam tug and fleet of barges are used.

IT is reported in *Electrical Engineering* that at the twenty-second annual meeting of the German Institutions of Electrical Engineers at Magdeburg on May 26th a monumental tablet to the memory of Werner von Siemens was unveiled, and lectures were given on recent progress in electrochemistry and electrometallurgy, electric steel refining, wireless telegraphy, and electricity on board ships. Professor Dr. Klingenberg, of Berlin, was elected president of the Verband for the year 1914-15. Herr Dettmar announced that the specification of the Verband for lightning protection of buildings had been accepted as standard by a large number of municipalities and other governing bodies.

SIR GODFREY BARING asked the Postmaster-General in the House of Commons whether the result of the recent high-speed wireless telegraphy demonstration in the United Kingdom was of such a nature as to convince the experts of his Department that it might be preferable in the near future to use wireless telegraphing for telephonic communication between distant towns in the United Kingdom, and so obviate the expense of the maintenance of land lines. Captain Norton, Assistant Postmaster-General, in reply, said that he would be sorry to commit himself to a definite opinion on this question at present. The demonstration referred to had no bearing on the question of the use of wireless telegraphy for telephone purposes.

AT an extraordinary meeting of the Council of the British Electrical and Allied Manufacturers' Association the following resolution was passed :—"That the Council of this Association, in meeting assembled this 8th day of June, 1914, deplore the untimely death of their late chairman, A. Bruce Anderson, who perished at the sinking of the Empress of Ireland in the St. Lawrence River, on the 29th of May, and desire to place on record not only the loss of the chief executive officer of the Association, through whose efforts mainly it has reached its present position, but also the loss of a personal friend; and that a copy of this resolution be sent to Mrs. Anderson with an expression of their deepest sympathy for her in her sad bereavement."

THE *Bulletin* of the South Australian Official Intelligence Bureau at Adelaide states that recently attention has been directed to a discovery of magnesite near Tumby, a township on Eyre's Peninsula. The Government Geologist, as a result of a visit to the district, which is known to contain a variety of minerals, has submitted to the Minister of Mines a comprehensive report on the deposits of magnesite, from which it appears that they are of a very high grade. The report adds that since it should be possible to mine and deliver the crude magnesite at Port Adelaide for not more than £1 5s. per ton, it is reasonable to believe that the working of the deposit near Tumby Bay has a fair prospect of success, provided always that the demand for the magnesite is constant, and that the quality of the mineral when shipped in bulk compares satisfactorily with the imported material.

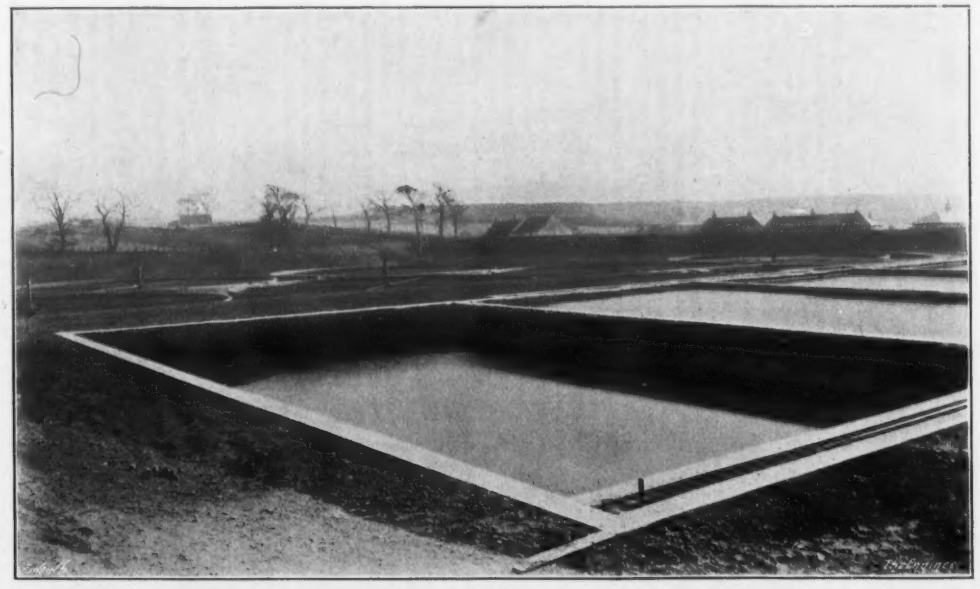
A GREAT scheme for the provision of oil supplies for the Navy is being worked out by the Government, says the *Standard*, and in order to prevent an undue accession in the price of desirable prospective fields the Admiralty are observing great secrecy regarding the movements of their agents. The idea, according to information obtained by a representative, is that the Admiralty shall establish immense stores of oil on British territory on all the main ocean highways, to replace coaling stations. In order to carry out this project, oil supplies are sought in territory as nearly contiguous to the proposed stations as possible, to reduce the cost of transportation to a minimum and to establish an ample and continuous supply. British agents are now in the United States, Brazil, Persia, Canada, and elsewhere prospecting for oil, but up to the present no details of their reports are available.

INFORMATION has been received at Devonport that the first of the tanks at the new Admiralty oil fuel depôt on the Humber, near Killingholme, will be brought into use at an early date, and it has been approved that the staff to be employed at this installation for the present is to be one first grade storehouseman, at 33s. to 39s. per week of six days, with charge pay of 1s. per day; one engineer, at 8s. 6d. per day; and three stokers, at 4s. per day for seven days a week. Two cottages have been provided at this installation, and have been allocated for the use of the storehouseman and engineer respectively. Each of these cottages contains five rooms, three being bedrooms, and a rent of 2s. 6d. per week will be charged for their use. The removal expenses of the men transferred, and also of their families, will be borne by the Crown. It is requested that volunteers for these positions may be called for from amongst the first grade storehousemen serving in the Naval Store Department and the fleet coaling and yard craft staffs.

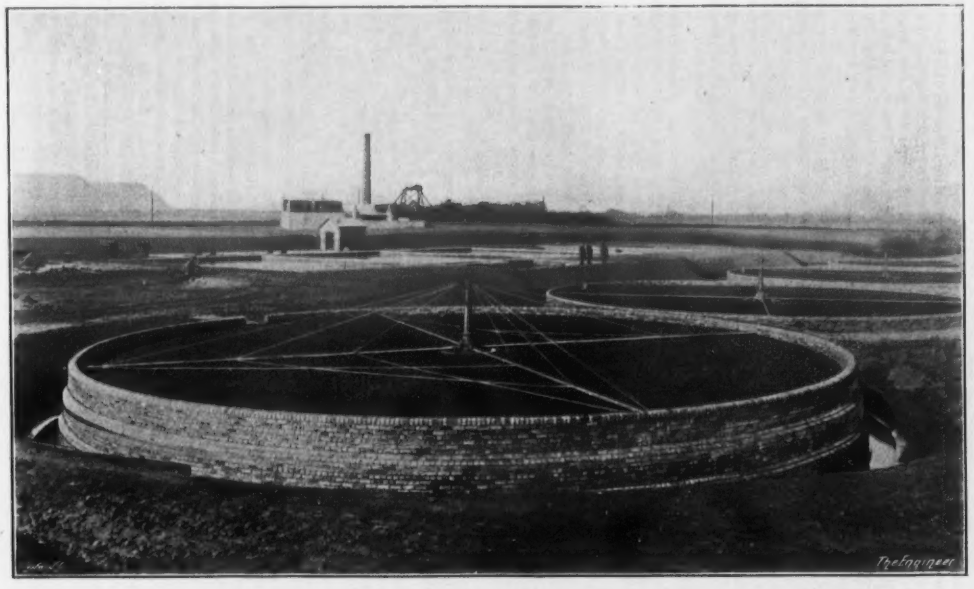
# SEWAGE DISPOSAL WORKS AT BROXBURN, LINLITHGOWSHIRE

MESSRS. HUNTER, DUFF AND MIDDLETON, LONDON AND EDINBURGH, ENGINEERS

(*For description see page 644*)

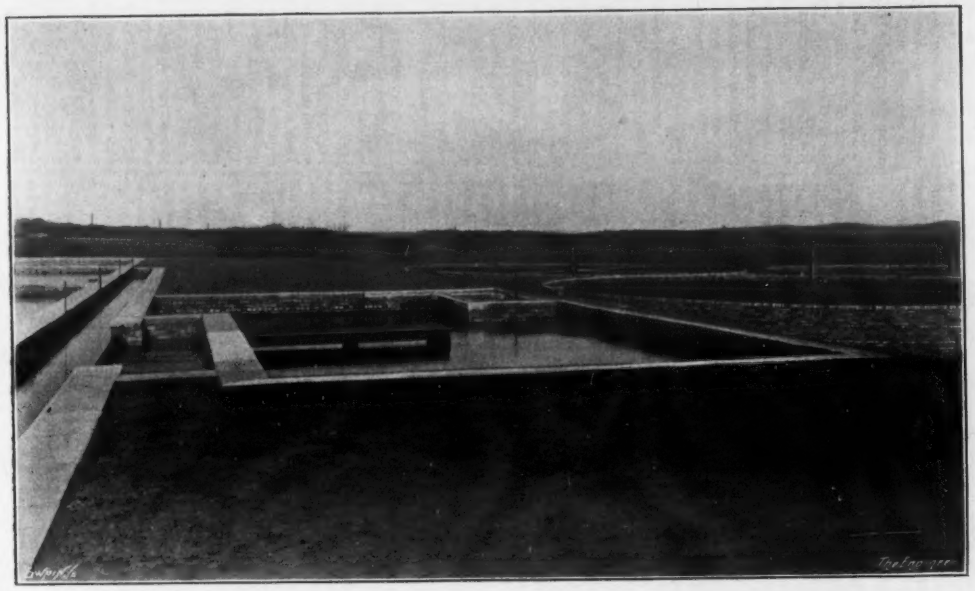


FLOOD WATER AND PRIMARY TREATMENT TANKS AND FILTER BEDS



CIRCULAR FILTER BEDS

PRIMARY TREATMENT TANKS



SETTLING AND DOSING TANKS

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# THE ENGINEER.

*JUNE* 12, 1914.

### The Suggested Wireless Telegraphy Research Committee.

The report of the Committee appointed by the Postmaster-General to consider "how far and by what methods the State should make provision for research work in the science of wireless telegraphy" has just been published as a White Paper. We reprint it in full in another column. Briefly speaking, it is proposed that a body, to be called the National Committee for Telegraphic Research, should be appointed and be furnished with a staff, a laboratory, and equipment for carrying out such investigations as it may consider necessary. It is suggested that the Committee should consist of twelve members, two representing the Admiralty, one the War-office, and two the Post-office; that of the remainder, two members should be directly appointed by the Treasury, three by the Treasury on the nomination of the Royal Society, and one by the Treasury on the nomination of the Institution of Electrical Engineers; and that the Director of the National Physical Laboratory should complete the number. The headquarters of the Committee are to adjoin the National Physical Laboratory at Teddington. The probable initial capital expenditure on the necessary aerial, buildings, and equipment is estimated at £7300, and it is calculated that, to begin with, the annual expenditure will be about £4800. As regards this question of annual expenditure, a majority of the Committee of Inquiry is in favour of not fixing an annual grant, but of allowing the proposed Research Committee to formulate its proposals for each year's work and to lay them before the Treasury with an estimate of the probable cost. It is further proposed that an honorarium of ten guineas be paid to each member of the Committee attending a meeting, but it is stipulated that the number of meetings paid for shall not exceed fifteen per member per annum in the first two years and ten per member per annum thereafter. In passing, it may be mentioned that the amount assigned for honoraria in the estimate of yearly cost is £1100, and as there are twelve members, each receiving ten guineas per meeting, it is quite obvious that either it is anticipated that there will not be as many as fifteen meetings or that all members will not attend all the meetings. Were this to be the case a sum of £1890 would be required for the various payments. While on this subject of payments we may say that in one or two cases the remuneration of the staff would appear to us to be on the low side. There is to be one "principal assistant," who will presumably be in charge of all the work carried on, and he is to receive a salary commencing at £400. We should have thought that such a man as will be required to fill the position would be worth more than that. Then, again, it is proposed to pay a secretary and a clerk the sum of £300 per annum, and the secretary must not only have technical training and experience, but must also be a French and German scholar as well. We doubt if such a man would be properly paid even at £300 a year, and that would leave nothing for the clerk.

The suggested subjects of investigation for the proposed Research Committee are set out in the schedule to the report, and need not be referred to in detail here. It is sufficient to state that they cover a wide field and would allow plenty of scope for the energies and ingenuity of the members and staff. They will not, however, be the Committee's only duties. It will have to work hand in hand with the Post-office, the Admiralty, and the War-office, so that work now being done by these departments may be continued and extended. At the present moment all these departments are so busily employed that it is possible to carry out little more than absolute routine work; but it is reasonable to expect that during the course of such work improvements would suggest themselves which, if scientifically followed up, might be to the benefit of the nation at large. It will be for the Committee to help in matters of this kind and to assist departmental engineers to carry out approved experiments, lending for the purpose the instruments in its laboratory. It will, further, have to consider problems submitted by the departments, to arrange for experiments for their elucidation, and to examine plans and designs for new methods when submitted—apparently by persons outside the Government departments. As a sort of *quid pro quo* for the services rendered by the departments the Committee may, if found convenient, use Government stations for experiments, which may be carried out better there than in the Committee's own laboratory. Moreover, the Committee is to have power in its discretion to organise or co-operate in international scientific investigations bearing on telegraphy, and its sphere of action, though it is primarily wireless transmission, is also to include ordinary telegraphy and telephony.

There is no doubt whatever that a Committee of properly qualified men could do good work in the interests of telegraphy and telephony if given adequate powers and funds and if it devoted sufficient time to the matter. The question which will have to be decided is whether the Committee, as it is proposed to constitute it, will do all that is necessary. The first point to be considered is whether men of the first rank will be willing or able to assist the Committee, for it is clear that none but those with the highest qualifications should be invited to serve. Then, again, would the proposed number of paid-for meetings be sufficient to keep the Committee as a whole properly in touch with the practical working of the laboratory? On that point some doubt is legitimate. It may be argued that as the Director of the National Physical Laboratory is himself to be a member of the Committee and as the laboratory is continually under his eye—the staff also being members of the staff of the National Physical Laboratory and subject in all respects to its rules—the Committee would, through him, keep properly in touch with its staff. But under such circumstances the new laboratory would simply become a department of the Physical Laboratory and would cease to act directly under the orders of the Research Committee. As we read the proposals, this is not the intention of the Committee of Inquiry. On the contrary, the report—to our mind—intends that the telegraphic research staff, though conforming to the same rules as the staff of the Physical Laboratory, should be under the orders of the Research Committee alone. That being so personal supervision on only a few days in the year would certainly not be enough to ensure the best results. It is possibly anticipated that the keenest and most enthusiastic of the members of the Committee will attend more frequently than the specified number of times a year, and will look for no payment for doing so; but is it wise to place reliance on any such action? We venture to suggest that it would be better that at least one member of the Committee—a man of unquestioned ability—should be permanently attached to the Research Laboratory. Dr. Glazebrook is a very able man, and if he had nothing else to do we could suggest no one better qualified than he to fill the position; but he has so many other things to attend to that he would only be able to give a small fraction of his time to telegraphic research work. We are by no means certain, either, that the estimates for either capital or annual expenditure will be found sufficient. This view would apparently also be held by all save three of the members of the Committee of Inquiry, for it is pointed out that the estimates only deal with requirements at the outset, and it is shown that even if the capital expenditure be increased by £3000 and the annual expenditure by £2000, the total cost would be less than the amount expended with a similar object by either the Government of the United States or of Germany. It will be generally admitted that it is desirable that our service of wireless telegraphy and telephony should be second to none. For this we must be prepared to make extended researches, and such researches cost money. In any case, the expenditure is not very great, and the small increase of it, which would enormously augment the efficiency of the Committee, would be well spent.

### Science and the State.

An interesting, if a not very profitable, discussion has been pursued in the *Morning Post* ever since Sir Ronald Ross, in addressing that curious body, the British Science Guild, a few weeks ago, suggested that the State ought to subsidise discoverers. Some people hold that science is better left to look after itself; others point out the difficulties of finding, encouraging and ultimately rewarding the right men; whilst a third party is indifferent to all obstacles, and would have doles and grants

made to all and sundry who show any ability in science work either, apparently, whether it be in teaching or in research.

It seems to us that a little clear thinking about what science is, what it can do, what it cannot do, and what is worth doing, is needed by many of those who have taken part in the debate. No word, probably, has been more severely strained in the course of its existence than the unhappy word science. Literally, it means, of course, no more nor less than knowledge, but in early Victorian days, when Prince Albert was devoting himself to the erection of the Science and Art Department at South Kensington, it was narrowed down to imply acquaintance with chemistry and physics, but, as training in applied thermo-dynamics began to increase, all forms of heat engines found their way under its ample folds, only to be jostled later by many other subjects connected with engineering. Ultimately, the science student was held to be one who studied any branch of engineering or chemistry—the two great divisions into which the curricula of science schools were divided. A better division came later when it was recognised that science, which in its best limited sense is the study of all natural laws, ought to be distinguished from technology, which is the application of such laws through industries to the use and benefit of man. We make this point because it is here that much confusion has arisen. The man of pure science works simply for the discovery of facts of nature; the man of applied science or technology studies the application of the discoveries of the pure scientist for purposes which are so solid that they may be mentioned on a company's prospectus. There is no money in the first; there is much money in the second. When a man combines in himself the two—as Lord Kelvin, for example, did—his reward is great, and there is absolutely no question of the State coming to his assistance. He makes plenty of money, and the recognition he wins from fellow-scientists the world over is a far higher and far more acceptable reward than any title or honour which he may have the privilege of sharing with those who buy it by handsome subscriptions to party funds. There is no real scientist who does not regard election to the Royal Society as greater than any honour a Cabinet can confer. But there are branches of science which have no possibility of ever being useful. The pursuit of astronomy is one, the study of the Adélie penguin another, and many more might be named—more honour to them! Enough astronomy is known for the needs of man, and if no more was ever done than the routine work of bringing astronomical tables up to date, the world would be none the worse off. It is hard to imagine that any one will find the study of penguin domesticity of more than absorbing interest to him—unless indeed he be a second Anatole France. We purposely set aside such abstract and fascinating questions as the mental elevation which is given by the study of things so absolutely outside man's control as the stars and planets and other sky-wonders. Where money is being considered, it is as well to keep our minds strictly to "brass-tacks," or we may next have a British Poets' Club urging that every youth who shows poetical propensities should be State endowed. The point is one of great consequence. We have mentioned astronomy because it is the most obvious and greatest of the useless sciences, but it is only the ultimate example of the fact that all science is useful to no one save the person engaged in it, and only useful to him as a mental training and to prevent him using his idle hands on the "mischief" which we know a certain discredited individual is always prepared to find for him. The first question, then, is: Should the State pay for and encourage these useless sciences? To it we think there can be no answer save one. Such work is best performed when it is done without any desire of pecuniary reward. We need not doubt that there will always be enough scientists to carry it on, men who are pure devotees of science and would give their whole lives and substance to break one small hole through her veil. Honours we are glad to see conferred upon such men when their life's work is drawing to a close, but to honour them in anticipation and to offer them public doles and financial assistance is to lower them from the high plane on which they work. They are far better left to win through in their own way and by the help of their own kind, which is never wanting where real merit is manifest, than to be trammeled by Government grants, which would no doubt lead to the demand by unsympathetic financial critics in the House of Commons for an annual account, in a blue paper cover, of their stewardship. We put aside, then, the pure scientist, the man with no ulterior objects, and ask the second question: Should the State pay for and encourage useful science? Here the ground is wholly different; such science is not its own reward, there is money in it, and on that account we say that the State should not make grants to it. Let us assume the case of a young man who desires to make researches into the question of the condensation of steam by shock. The State, deciding to look upon him as a budding discoverer, supports him and pays for his experiments. After a few years' work at the expense of the taxpayer, he does by chance make a great discovery. To whom is it to belong? That the State should assert its right to it is inconceivable; but if, on the other hand, the young man is allowed to sell his knowledge for much money, the State finds itself in a strange position. If it could support for five, six or ten years an inventor in order that at the end he might make a competence for himself, why should it not support for the same time a young shopkeeper or a young solicitor? Why should it do more for science than for art, literature, the law or shopkeeping? If, to avoid this awkward contingency, the State decides that the discovery is to be public property, no one thanks it, and there is a rush to the Patent-office to "corner" all its applications. It must never be forgotten that the "science" followed by the bulk of young men who are induced to go into technical schools and college is business science, science out of which they expect to make money, and there is no more reason why the few kinds of science which we include in a science school curriculum should be favoured by State assistance than that the science of law, art, literature or shopkeeping should be so favoured. "Science" is a branch of an engineer's calling, just as "double-entry" is a branch of the calling of a chartered accountant.

Of course, in what we have written we have kept the science of engineering only in mind. Medicine and economic botany and some branches of physics are, no doubt, in certain respects on a different plane, but even drugs and manure may be patented, and the science of medicine successfully applied does not seem to be without its reward. In any case, they are outside our field, and it would be impertinence on our part to discuss them. On the other hand, as far as those sciences—and they are many—connected with engineering are concerned, we fail to see that any real good would be done by subsidising individual research, and we are convinced that the difficulties in the way are very great. It must not be forgotten that each branch of the industry already spends large sums of money annually either in laboratories attached to factories, in the laboratories of private investigators, by funds given to learned societies for the pursuit of inquiries, by scholarships to colleges, and in many other ways. Engineering does a great deal to encourage research, and it does it in the best and most natural way. We are convinced that as far as it is concerned it is better left to look after itself, and that State subsidies to individual "discoverers" are impracticable and unnecessary.

### The Export Coal Trade.

THE custom of concluding contracts a long time in advance largely explains why the coal trade is usually one of the last branches to experience the effects of a general improvement in the economic situation, and it also accounts for the circumstance that the coal trade is one of the last to feel the results of an unfavourable reaction in trade and industry in general. As the latter state of affairs has prevailed for some time past, it was only natural to expect that the coal trade would also become involved in the downward movement, and this has recently taken place both in the home and export markets. Our foreign trade, for instance, exhibits a decline in the quantities and the values of the coal exported in the first five months of the present year as compared with the corresponding period of 1913, although it does not appear that the average prices of the tonnage actually sent out of the country have varied much in recent months. The loss of important foreign contracts in recent times must of necessity have affected British quotations for new business, and lower prices will consequently prevail where the competition of continental producers comes into operation if further contracts are not to pass into other hands. During the first five months in the current year the reduction in the values of the exports has amounted to £980,000 as contrasted with the equivalent term in 1913. This shrinkage, however, is not of particular significance when it is remembered that the increase in the exports in the whole of 1913 over 1912 reached about 9,000,000 tons, representing a greater value of over £10,000,000. But the proportionate advance in values in 1912 over 1911 was of even larger extent, as while the total exports were approximately the same in each year—64,440,000 tons and 64,599,000 tons respectively—the values rose by nearly £4,000,000 in 1912. The augmentation in values represented by these figures was brought about on the one hand indirectly by the strike of British coal miners in the early part of 1912, and on the other by the general expansion in the trade of foreign countries, which continued in the case of British exports throughout the whole of the following year, as has previously been pointed out.

It is of some interest in this connection to investigate the manner in which the course of prices in recent years has affected the quantities of coal exported between two ranges of prices. If we first refer to the year 1911 it is found, according to the official annual return, that the largest quantity of coal exported at one range of prices was composed of sorts of the value of from 9s. to 10s. per ton, the tonnage being 13,443,000, whilst only 4,802,000 tons were exported at prices exceeding 16s. per ton. On the other hand, the latter scale of prices prevailed for the largest quantity—9,902,000 tons—exported in 1912, whereas the tonnage exported at the lower range only attained 8,197,000 tons in the same year. The figures for the past year are still more remarkable, as they indicate a further appreciation of the superior qualities of British coal. For instance, the greatest volume of the exports, 17,707,000 tons, was at the higher scale in question, and the tonnage sent out of the country at the lower range was only 3,790,000. It is scarcely necessary to say that the higher-priced qualities of coal were almost entirely composed of Welsh coal shipped from the Bristol Channel ports, and it is therefore reasonable to conclude that the war in the Balkans and the possibility of European complications had a stimulating influence on the extensive requisitions for Welsh qualities. At any rate, it appears impossible otherwise to account for such a remarkable development in the export trade in special classes of coal from one particular district.

The fall in the tonnage of exports in the present year may have resulted from a decline in the international demand or from an increase in foreign competition, or from both causes. It is probable that the former has already played a certain part in the matter already, judging from the countries of destination given in the Board of Trade returns, whilst the recent accentuation of foreign rivalry will only be indirectly reflected in the returns for the ensuing months. It will, however, be necessary for British exporters to follow more closely than ever the movements of the export associations in Westphalia, as it will only in this way be possible to check any further invasions of markets which British exporters at one time claimed to be their own special preserves. The general slackening of the industrial demand which prevails in France, Belgium, Germany, and other countries, to say nothing of Great Britain itself, is bound to bring about an accentuation of competition on the part of Westphalian coal producers in the near future, and it is surprising after all the lessons of the past that British coal firms have failed to grasp the value of combination in the promotion of the export trade. However strong they may be at present in the markets of the world, they will have to reckon with growing rivalry, not only in Europe, but also, in all probability, with the competition of coal producers in the United States on the complete opening of the Panama Canal, in so far as certain markets in South America are concerned.

## HIGH-POWER DIESEL ENGINES.

WE publish elsewhere this week extracts from a paper on "Diesel Engines," which was read by Mr. James Richardson, B.Sc., before the Junior Institution of Engineers some time ago. It is one of the most practical papers that has been read on the subject, based as it is largely on the actual experience of the author in Diesel engine construction. But it is of great length, and in order to save the time of those who are too busy to read it right through, we propose to deal briefly with some of the points raised. The author states as his opinion at the start that the marine Diesel engine has not fulfilled the expectations of the early enthusiasts, for the reasons that designs were based upon pure theory without the necessary scientific experimental work in advancing from one size of cylinder to a bigger one, and that it was assumed that the conditions applying to the construction of land engines would apply equally well to the construction of marine engines. He does admit, however, that entire success has been achieved by those firms who were primarily marine engineers, who have been conservative in increasing cylinder diameter, who have made no attempt to cut weight, and who have stuck to the four-cycle. Though he gives no names, his remarks clearly indicate two of the firms referred to, and we have obtained from them—Messrs. Burmeister and Wain, of Copenhagen, and the Nederlandsche Fabriek, of Amsterdam—a table showing the progressive increases in diameter of cylinder made by them during the last few years.

The author then proceeds to consider future possibilities, but in this he appears to be of opinion that the four-cycle engine has reached the limits of its success as he rules it out, and confines himself to the two-cycle on the plea that "the power of the four-stroke cycle engine is limited by the difficulties of dealing with the exhaust unless auxiliary exhaust ports be introduced." These auxiliary exhaust ports, he points out, would, while overcoming the difficulties with the exhaust valves, lead to a reduction in the mean effective pressure on the expansion stroke by early opening and on the compression stroke by late closing. The latter objection could, however, be overcome by putting the admission air under a slight pressure, and we venture to think that even with the trifling loss on the expansion stroke, a forced induc-

*Burmeister and Wain.*

| Date. | No. of cyls. | Dia. | Stroke. | Revs. | I.H.P. | I.H.P. per cylinder. |
|---|---|---|---|---|---|---|
| | | mm. | mm. | | | |
| 1911 | 8 | 530 | 730 | 145 | 1250 | 156 |
| 1912 | 8 | 590 | 800 | 125 | 1500 | 187 |
| 1913 | 6 | 740 | 1100 | 100 | 2000 | 333 |

*Nederlandsche Fabriek.*

| Date. | No. of cyls. | Dia. | Stroke. | Revs. | B.H.P. | B.H.P. per cylinder. |
|---|---|---|---|---|---|---|
| | | mm. | mm. | | | |
| 1909 | 4 | 320 | 420 | 235 | 190 | 47 |
| 1910 | 6 | 400 | 600 | 150 | 450 | 75 |
| 1912 | 6 | 560 | 1000 | 125 | 1100 | 183 |

tion, auxiliary exhaust port, four-cycle engine should maintain its present position *vis à-vis* the two-cycle. The author admits in the next line that the gain in weight and space occupied with the two-cycle is not great, and that even the small saving is neutralised by the greater fuel consumption; and his real claim is justly founded on the fact that the two-cycle engine gives the greatest mean effective pressure per revolution.

A condition with regard to the speed of revolution of the Diesel engine which is very generally overlooked is involved in the statement that "the accuracy of workmanship and the excellence of materials required by those parts subjected to pressure and to temperature make it possible economically to run the oil engine at a relatively high normal speed of revolution." We are not at all sure that we agree with the author in his suggestion, which comes a little later for raising the mechanical efficiency of a Diesel engine by dividing up the fuel injection between two or more fuel valves opening at different periods of the stroke. He suggests that the valves which open after the preliminary ignition charge has been injected would require a lower pressure of air for the injection of the fuel, and that this would result in a reduction in the size of the compressor and the power required to drive it. This reduction would, however, we believe, be so trifling in practice as not to be worth the expense of the extra valves with their driving gear, simple though the latter might be. The figures given by the author in reference to the maximum load on the main bearings of a steam engine as compared with the corresponding figures from an oil engine, are very significant, especially with regard to the rate of change, in their relation to the strength of the crank shaft, framing, and bed-plate. A very important point is also brought out in the diagrams showing the forces acting on the guide, which in an oil engine are reversed and not constant, as with the steam engine; this, again, is an item not generally realised. The portion of the paper dealing with the engine framing is especially interesting, and the importance of keeping the load as near the centre of the shaft as possible and of relieving the cylinder altogether of longitudinal stresses, is clearly demonstrated.

An interesting portion of the paper is, too, that which deals with cylinder castings and the various forms they may take and the stresses they have to withstand. The author is in favour of the jacket, liner, and cover being made as three separate units, even though this arrangement involves a somewhat big mass of metal at the top of the combustion chamber, which is difficult to cool. He proposes, however, to overcome this difficulty by means of a novel design of cover, in which the load is taken on a steel plate bolted down to the cylinder flange in the usual way, whilst on the underside of this plate and spigoted into the bore of the cylinder is a cast iron water container, as shown by an illustration in the paper. By means of the spigot the combustion chamber is carried down well below the mass of metal formed by the junction of the liner with the cylinder, and so could be completely water-jacketed, and the author claims that the construction is simpler and that the water spaces are more accessible. We are afraid that we can hardly agree that the form of construction is simpler than an ordinary cast iron cover *with the same number of valves in it*, and we cannot believe that it would be an easy job to make a good joint for the valve cage between the steel plate, which is comparatively cool, and the cast iron, which is subject to the full explosion temperature on one side and water on the other. The author apparently only suggests the plan for engines with port scavenging—that is, with only the fuel valve in the cover—and he no doubt recognises that it would be infinitely more difficult if there were two or three valves. It appears to us that the only way in which these joints could be made satisfactorily would be to cast a boss up from the bottom part to a height equal to the sides, and to machine this face flush right across; the steel plate would then make the water joint on the outer edge of the top of the boss. It would be provided with a hole round the central part of the boss, through which the valve could be jointed on to the face of the boss clear altogether of the steel plate. One of the objects aimed at by the author could be achieved by simply putting a more or less shallow spigot on the underside of a cover of ordinary form.

What would have been the most valuable portion of the paper but for one omission is that which deals with the materials of which cylinders and liners should be made. Not only are the conditions which such materials have to fulfil given very clearly, but their constituents are hinted at, and the author shows in the form of a table the serious effects of "growth" in cast iron of unsuitable mixture and the reduction in "growth" when cast iron of a suitable mixture is used. The, perhaps natural, omission to give away the composition of this particular mixture goes a long way to detract from the value of the rest of the information, though at this we have undoubtedly no right to cavil. A lot of useful information follows on the subject of compressors, scavenging pumps, starting, &c., and we are glad to note that preliminary warming of the cylinders is recommended before starting up, as tending both to facilitate starting and to relieve the cylinders of excessive temperature variations. We have only space here to touch upon so few of the many interesting points dealt with by the author that we would recommend those who wish for fuller information to read through the paper itself.

## LITERATURE.

*Igneous Rocks.* By Joseph P. Iddings. Vol. II. Pages, 9in. by 6in., xi. and 685. John Wiley and Sons. Cloth, 25s. 6d. net.

*General Metallurgy.* By H. O. Hofman. Pages, 9in. by 6in., xiii. and 909. McGraw-Hill Book Company. Cloth 25s. net.

THE authors of these two books are men of the highest standing in the scientific and technical circles of the United States, and yet display in a marked manner, in these instances perhaps unconsciously, that curious striving for originality which so frequently mars the work of their countrymen. In Professor Iddings' case the result is rather irritating without compensatory advantage, but in Professor Hofman's case the result is a distinct success, which is the more agreeable as it could never have been anticipated from the magnitude of the task undertaken. The phase assumed by Professor Iddings' originality is a laborious endeavour to make an inauspicious system of classification, to which he himself is much attached, appear useful; whilst that of Professor Hofman is the inclusion in one comparatively small volume of a wide field of technology usually regarded as without the range of metallurgy as well as the whole extensive range of that comprehensive subject itself, and he has done it well. The book is indeed a masterpiece of lucidity and compression; the latter feature is greatly aided by the liberal and sensible use of chemical formulæ.

Of course, as one would expect from him, Professor Iddings, in spite of the vaunted classification, furnishes in Part I. of his book a mass of valuable information relating to composition, texture, classification, description, and occurrence of rocks; and these in such numbers that the mere contemplation of their names is appalling. In Part II., by the aid of maps, he indicates the very extended distribution of these rocks over the surface of the earth and gives some account of the rocks encountered at each locality. This section of the book is quite attractive, and one rather wishes that some descriptions of other rocks were also given, but the restrictions indicated by the title preclude this. This volume should prove a useful book for reference; although the author's own references are inconveniently massed together at the end, where, too, Vol. II. is referred to as Part II.; but there are many slips in both books, including an upside-down figure—Hofman, p. 321.

Professor Hofman disposes of his prodigious task in thirteen chapters. A short one of a page and a half provides an introduction, and Chapter II., pp. 3 to 32, deals with the "properties of metals." Every metal known seems to be included, as well as different forms of the same metal; for example, iron, molten iron, wrought iron, steel, white cast iron, grey cast iron. Many, many mysteries of bygone days may be dispelled by perusing this chapter. Chapter III., pp. 33–69, is devoted to "Alloys," and the characters of these substances are set forth in a systematic and progressive manner; binary alloys to start with, with simple equilibrium diagrams passing onwards until the most complex are reached, with diagrams that recall sections of Chinese puzzles; but all clearly explained. "Metallic Compounds" receive attention in Chapter IV., pp. 70–102, and "Ores" in Chapter V., which covers less than a page; yet this queer little chapter contains a definition of ore that is by no means generally accepted. The chapter on "Fuel," pp. 104–340, includes all sorts of fuels, solid, liquid, and gas, as well as the ways of preparing them—briquetting, coking, producers, &c.—and using them. Even liquid fuel burners are included, and their relative merits and pyrometry are well set forth. In Chapter VII. "Refractory Materials" find place, pp. 341–378, whilst Chapter VIII., pp. 379–503, furnishes a fine review of "Pyrometallurgical Processes and Apparatus," and there are iron, copper, and other blast furnaces, reverberatory furnaces, furnaces fired with dust, with oil, with gas, electric furnaces, &c. &c., all set forth in rich profusion. "Hydrometallurgical Processes and Apparatus" and "Electrometallurgical Processes and Apparatus" are treated more briefly and find place in Chapters IX. and X. respectively. Chapter XI., pp. 534–883, covers a great range of subjects, including those already noted as not usually appearing under the head Metallurgy. Here we may read about gold milling and its machinery; ore dressing and its appliances, with pumps, filter presses, &c.; rolling mills; wire-drawing; blowing machinery; blast heating, blast drying by freezing; gas washing and fume and dust separation, and much more. Chapter XII. briefly notices "Metallurgical Products," and Chapter XIII. "Economic Considerations." All the matter is abundantly and well illustrated by figures and diagrams, whilst references to literature are numerous, and in this case handy at the place where wanted.

The author set out to cover the field of general metallurgy as a whole; to combine the results of older work with those of modern research, and to treat the whole from the point of view of the metallurgist, with a leaning towards physical chemistry. Mechanical processes were to receive more consideration than has been customary; technical literature was to be drawn on freely; all this is precisely what the author has done, and, in conjunction with an ample draft on his own personal observations, has, as a result, produced this highly valuable volume.

## SHORT NOTICES.

*The Riddle of Mars.* By C. E. Housden. London: Longmans, Green and Co.—This is a small volume—it contains less than seventy pages—but it is amazing in its boldness. In Mars, we read, there is no rain. The water evaporated is returned to the surface in the polar regions in the form of ice spicules, hail, snow or sleet. This fact, according to the author, is the key to the riddle of Mars. The polar caps melt twice a year, and the water thus set free, again according to the author, is utilised in a gigantic artificial irrigation system of which Lowell's "canals" are the outward signs. During part of the year the Martians draw upon the underground water for their irrigation supplies. The author indulges in much hypothesis, and advances statements and beliefs on evidence of the extremest tenuity. Among other matters, he calculates the size and number of the irrigation pipes, and the situation and the capacity of the irrigation pumping stations. In our opinion, this is science run mad; nevertheless, the book makes interesting reading for an idle hour.

*Marine Engineering.* By Engineer-Captain A. E. Tompkins. London: Macmillan and Co.; Limited. Price 15s. net.—This is the fourth edition of Engineer-Captain Tompkins' well-known and valuable work. Since the third edition was issued six years ago marine engineering practice has advanced considerably, and, accordingly, we find the present volume in a revised and partially re-written form. The principal additions are made in the chapters on the marine steam turbine and internal combustion engines. The book aims, of course, at being a general treatise on marine engineering, and hence does not go very fully into any particular subject. Still, it strikes us as somewhat curious that in the chapter on internal combustion engines attention should be concentrated on ordinary types of oil and gas engines, ignition systems, and gas producers, while the Diesel engine is dismissed almost perfunctorily.

*Structural Geology.* By C. K. Leith. London: Constable and Co., Limited. Price 6s. 6d. net.—It is eminently desirable that a student having mastered a general treatise such as Professor Park's should proceed to the study of specialised works on the different branches of geology. Mr. Leith's book is one such as this, and deals with the study and interpretation of rock structures as such structures affect stratigraphy, the unravelling of the earth's history, and the application of geology to mining, civil engineering, &c. The volume is well written and illustrated, but here, again, we have to complain that the work and memoirs of the Geological Surveys of the United States and Canada are relied upon almost exclusively for furnishing illustrative examples.

## BOOKS RECEIVED.

*Heat.* By E. M. Shealy. London: The Hill Publishing Company, Limited, 6, Bouverie-street. Price 8s. 4d. net.

*Gas and Oil Engine Management.* By M. P. Bale. Fourth edition. London: Crosby Lockwood and Son. No price stated.

*Commercial Paint and Painting.* By A. S. Jennings. "Westminster" series. London: Constable and Co., Limited. Price 6s. net.

*South Wales Coal and Iron Companies*, 1914. Cardiff: The Business Statistics Company, Limited, 12, James's-street. Price 1s. net.

"*Electrical Review*" *List of Electricity Supply Undertakings, Electric Tramways and Railways, and Electric Power Companies of the United Kingdom.* London: H. Alabaster, Gatehouse and Co., 4, Ludgate-hill. Price 1s. net.

## WATER-SOFTENING PLANT AT HOOTON, CHESHIRE.

IN view of the great amount of attention which is now being paid to the provision of pure and wholesome water by public authorities in this country, the plant for softening and eliminating the iron from the water supplied from Hooton by the West Cheshire Water Company to some eight townships is of special interest. This company obtains its supply of water by pumping from boreholes with an average depth of 800ft., but until recently the water did not comply with the requirements of an Act of Parliament which stipulates a limit of 10 deg. of hardness. The water also contains iron in solution. The analysis of the initial hardness of the water is as follows:—Temporary hardness, 12 deg.; permanent hardness, 7 deg. = 19 deg. total hardness. It was therefore decided to lay down a plant on the Permutit system, of which the following is a description. Figs. 1 and 2 are from photographic views of the plant, Fig. 1 being a view of the iron eliminating apparatus and Fig. 2 a general view of the softening plant. Fig. 3 shows the whole plant in plan and elevation, and Fig. 4 is a sectional elevation of one of the softening units, of which there are fourteen. Briefly it may be stated that a direct-acting pump forces the whole of the water, amounting to 2,000,000 gallons per day, through the iron eliminating plant—Fig. 1—where all traces of iron are removed. One-half of this volume is then passed through the sodium Permutit softeners before mixing with the other half of the crude hard iron-free water. In this way the water entering the public mains is reduced to an average of 9 deg. of hardness; this degree by an adjustment of the main valves being variable at will. It should be pointed out that the iron eliminating and softening plant is placed on the delivery side of the pump, and is consequently under the pump and main pressure, which varies between 80 lb. and 90 lb. per square inch. The iron eliminating plant consists of two manganese Permutit filters, each 9ft. diameter by 12ft. high, tested to a pressure of 150 lb. per square inch. The water containing iron enters the filter at the top and percolates through the manganese Permutit, where the iron is precipitated and arrested by the oxygen liberated from the manganese base.

Leaving these filters at the bottom the water then passes to the sodium Permutit plant, where it undergoes a softening process. It may be mentioned that the filters for removing the iron are each capable of treating two million gallons of water before it is necessary to regenerate the manganese Permutit. The latter is a body highly charged with oxygen, which it gives off to salts having an affinity for oxygen, and it continues to liberate oxygen and have a purifying action until the whole of this gas has been absorbed, when regeneration is necessary. This is done by passing through the base a solution of potassium permanganate from which the Permutit abstracts oxygen, which it retains. Before the regenerating process it is necessary to flush back the precipitated iron by reversing the flow of water through the filters. The regeneration of the filters occupies twelve hours, and 800 gallons of solution are required for each unit. The outlet for the regenerating solution is so arranged that it is impossible for the latter to pass through too quickly, and under no circumstances is it possible for the Permutit to avoid being submerged in the solution. On the completion of the regeneration process the hard water is allowed to enter the plant at the top to wash away any traces of regenerating solution still in the plant. This operation only occupies a few minutes, and as soon as the filter is cleaned it is again ready for operation.

The sodium Permutit section of the plant consists of two batteries, each of seven units, each unit being 9ft. diameter by 12ft. high, and working under a pressure of between 80 lb. and 90 lb. per square inch. The two batteries are so arranged that one battery suffices to treat the whole supply for twelve hours, after which it is shut down for regeneration, and the other battery put into action. The second battery then treats the water for twelve hours, while the first battery is undergoing regeneration, and so on. The iron-free water enters the softening filters at the top, percolates through the sodium Permutit, and leaves at the bottom free from traces of calcium and magnesium, being delivered at zero degree of hardness. As our readers are already aware, the action of the sodium Permutit is one of base exchange, the active base in the Permutit being sodium, and those of the water calcium and magnesium. In passing through the plant the calcium and magnesium are absorbed in exchange for the sodium, which is turned out and absorbed by the water. The action is, of course, purely chemical, and there is no visible alteration of the water, no precipitate or sludge being formed.

To revivify the Permutit a 10 per cent. solution of sodium chloride is used. Before this is introduced into the battery the Permutit is agitated by reversing the flow, that is, the water enters at the bottom instead of at the top, the object being to remove any air and to fill up channels which may have been formed during the softening process. When this operation has been completed the salt solution is pumped into the sodium Permutit filters at the top and percolates slowly through the medium. The spent solution is a clear liquor containing calcium and magnesium chloride, and it leaves the filter by means of a tap placed at about the same level as the top of the bed of Permutit, thus obviating any possibility of error on the part of the attendant and ensuring perfect regeneration. The process of regeneration occupies ten hours, and after its completion water is permitted to enter the softeners at the top to wash out the traces of salt, an operation which takes only a few minutes. The sodium Permutit, being insoluble, never requires renewing. There is no formation of sludge, and during the active working of the plant no chemical nor other reagent comes in contact with the water under treatment.

The mixing of the salt or regenerating solution is done

Fig. 1—IRON REMOVING PLANT

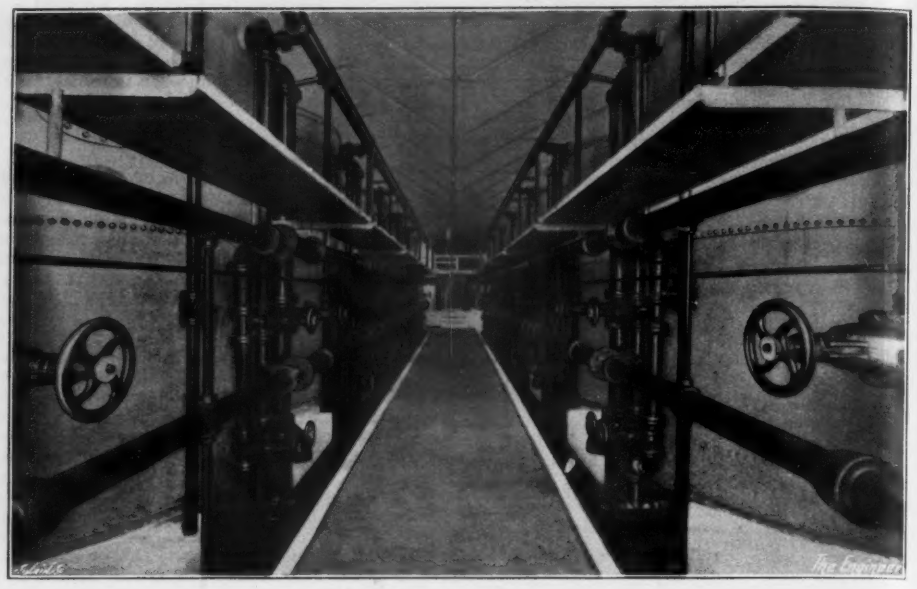


Fig. 2—GENERAL VIEW OF SOFTENER HOUSE

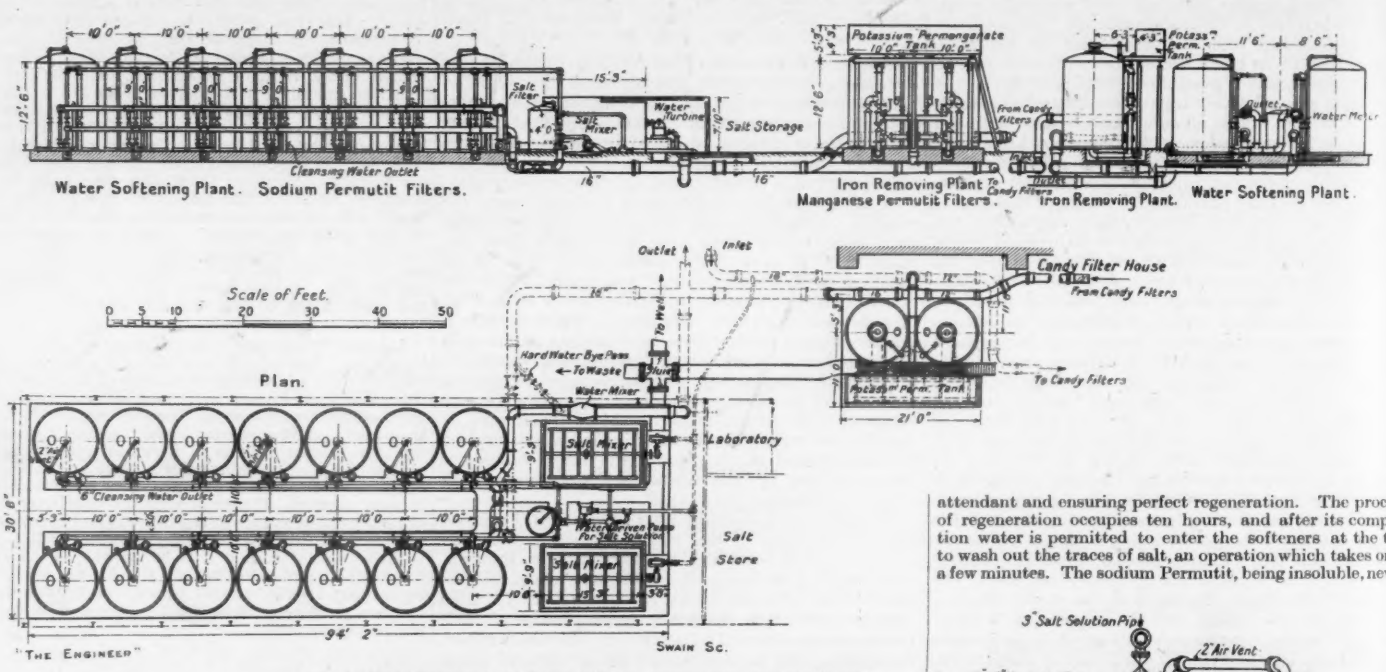



Fig. 3—ARRANGEMENT OF THE WATER SOFTENING INSTALLATION

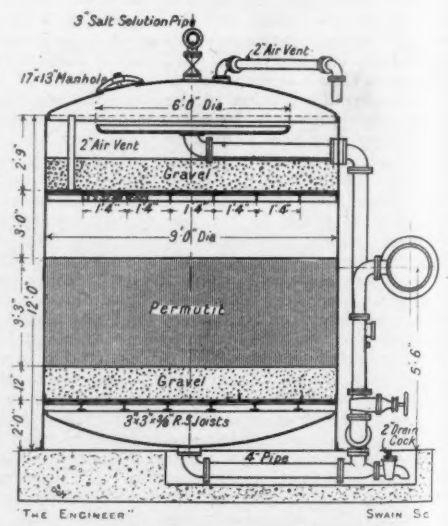
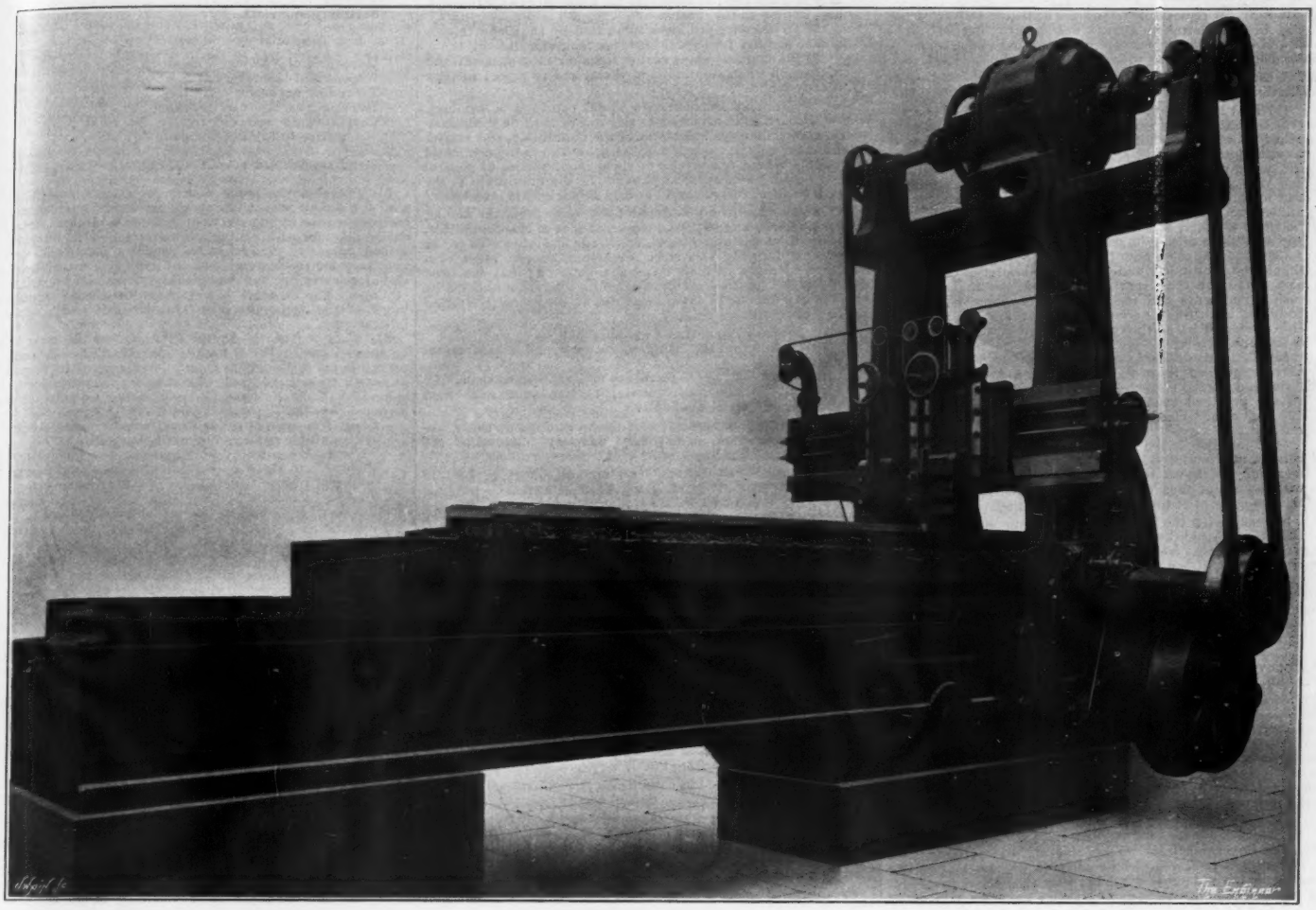



Fig. 4—PERMUTIT SOFTENING UNIT

# SEVENTEEN-FOOT RAIL-PLANING MACHINE

SMITH AND COVENTRY, LIMITED, MANCHESTER, ENGINEERS



in ferro-concrete tanks—Fig. 3—where a 10 per cent. solution is prepared, and the salt on its way to the filters is passed through a mechanical filter to arrest any foreign matter or dirt. After passing through the sodium Permutit plant the water is mixed in a chamber with an equal quantity of water from which the iron only has been removed. After becoming thoroughly mixed the resultant water is passed into the mains at, as we have said, about 9 deg. of hardness. A feature claimed for this process is that the mixing of the two waters is unaccompanied by any reaction, owing to the fact that carbonic acid gas is not affected by the Permutit.

It will have been observed that the installation is free from moving parts, with the exception of the pump, which lifts the salt solution from the mixing tanks. This is of the centrifugal pattern driven by a Pelton wheel. The salt is mixed by allowing the water to enter the tank at several points at the bottom, the amount used being about 2 tons 17 cwt. per battery for twelve hours. The water used to drive the Pelton wheel is afterwards led back into the well, so that there is no loss on this account, while the water required for agitating the filters before regeneration can also be led back to the suction reservoir, as it contains no dirt.

The wash water for removing the traces of salt after regeneration is allowed to run to waste. The water used for agitating purposes can be returned to the reserve tank, but at the present time this course has not been adopted, and the water is also led to waste. The total waste, including water used to make up the salt solution—10,000 gallons at each regeneration—is equal to 58,000 gallons, while 2,000,000 gallons of water are delivered to the mains.

The plant at Hooton has now been at work over fifteen months with complete satisfaction, the water entering the mains being at no time harder than the specified 10 deg. The wastage is small, and the cost of treatment per 1000 gallons delivered, including salt for the sodium filter and potassium permanganate for the manganese filters, interest on capital, depreciation, and attendant's wages, amounts, we are informed, to 0.7d.

## RAIL PLANING MACHINE.

THE accompanying illustration represents one of the two large rail planing machines built by Smith and Coventry, Limited, Manchester, under the new Bateman patents, to which our Manchester correspondent referred in these columns on May 22nd. The machines have a stroke of 17ft. and are fitted with two tool boxes on the cross slides arranged to carry four tools and self-acting in the horizontal traverse. As we have already described the chief points of this type of tool in THE ENGINEER, October 11th, 1912, we need do no more than mention that the most essential feature of the machines is the exceptional utilisation of fly-wheel energy, combined with its prompt application to the gears controlling the movement of the table. Two fly-wheels are employed, one on either side of the machine. They are driven continuously by open belts and are alternately coupled up to the cutting and return trains of gearing by means of friction bands carried in the fly-wheels. These bands are instantaneously brought into contact with the peripheries of the pulleys keyed on to the driving shafts. On the cutting side there is, in addition, a positive clutch connection between the fly-wheel and the pulley which is brought into use automatically immediately the reverse preceding the cutting stroke is completed. Both cutting and return belts run in the same direction, so that the fly-wheel on the cutting side has the assistance of the fly-wheel on the return side when cutting, and *vice versâ*.

The arrangement of the gearing renders high belt velocity unnecessary. It never exceeds 2500ft. per minute even on the quick return stroke. Another feature of the tool is the steadiness of the drive, which is largely brought about by the fact that all the gear wheels, with the exception of one pinion run loose on their shafts, thus eliminating torsion in the shafts and transmitting the power through the peripheries of the wheels themselves. The bed, table, and other parts of the machine are of ample proportions, the centre portion of the bed, which is the part subject to the greatest stresses, being continued below the surface of the floor, making a total depth of 36in. The leading dimensions of the machine are as follows:—Distance between the uprights, 3ft. 6in.; width of table, 3ft. 4in.; depth of cross slide, 1ft. 9in.; distance from the underside of the cross slide to the table, 12in.; range of feeds, ⅛in. to ½in.; cutting speed, 30ft. per minute; return speed, 100ft. per minute; bull-wheel, 48in. diameter; teeth in bull-wheel, 8½in. wide.

The following tests of the machine have been supplied by the makers:—

| | | | |
|---|---|---|---|
| Length of stroke .. .. | 16ft. | 8ft. | 4ft. |
| Cutting speed .. .. .. | 30ft. | 30ft. | 30ft. |
| Return speed .. .. .. | 100ft. | 100ft. | 100ft. |
| Number of cycles .. .. | Five | Five | Five |
| Calculated time .. .. | 3 m. 28 s. | 1 m. 44 s. | 0 m. 52 s. |
| Actual time taken .. .. | 3 m. 30 s. | 1 m. 45 s. | 0 m. 55 s. |
| Time lost on nine reversals | 2 s. | 1 s. | 3 s. |
| Average horse-power indicated during test .. .. | 2.35 | 2.4 | 3.06 |

In a test on two steel rails—50 tons tensile—four tools cutting, each tool taking a cut 1in. deep with ⅛in. feed, cutting speed 30ft., the average horse-power indicated during the test was 9.22. The length of the cut was 11ft. starting at nothing and finishing as above. On two steel rails as above, two tools cutting, each tool taking a cut 1¾in. deep with ⅛in. feed, cutting speed 37ft., the average horse-power indicated during the test was 9.2. The length of the cut was 9ft.

IT is reported that Sir William Willcocks has been retained by the United States Government as a consulting engineer in the Reclamation (Irrigation) Service. He is said to have left Phœnix, Arizona, recently for Yuma, Arizona, and will make a tour of all the Government irrigation works.

## WIRELESS TELEGRAPHY RESEARCH.

THERE has just been issued as a White Paper, Cd. 7428, the report of the Committee appointed by the Postmaster-General to consider and report how far and by what methods the State should make provision for research work in the science of wireless telegraphy. We reprint it in full below.

*To the Right Hon. C. E. Hobhouse, His Majesty's Postmaster-General.*

Sir,—Under the terms of our appointment we were requested to consider and report how far and by what methods the State should make provision for research work in the science of wireless telegraphy, and whether any organisation which may be established should include problems connected with ordinary telegraphy or telephony.

2. Immediately after our appointment we took measures to inquire (1) what work either by way of experiment or research in matters connected with wireless telegraphy was being already done by Government Departments in this country, and (2) what work was being done on similar lines by State Departments or Institutions in the United States and in Germany.

3. As the result of our first inquiry, we ascertained the several facts stated in the four following paragraphs of this report.

4. Valuable work in the way both of experiment and of research has for some time past been and is now being done in the engineering department of the General Post-office. Such department, however, is sometimes hampered by insufficiency of funds, and the matters it investigates are unavoidably such as have an immediate bearing on service problems rather than on the principles which underlie wireless telegraphy on its scientific side.

5. Valuable work by way of experiment and research is also being done by the Admiralty, but this, as might be expected, is almost entirely restricted to matters having an immediate bearing on the adaptation of the methods of wireless telegraphy to meet service conditions.

6. Some work is also being done both by way of experiment and research by the War-office, but again chiefly with a view to the practical requirements of the military authorities.

7. Those responsible for the departmental work to which we have referred are of opinion that further experiment and research in matters of general principle with which the departments cannot under present conditions deal themselves is urgently needed. A detailed list of such matters has been laid before us, and will be found in the schedule hereto. It will be seen that some of these matters can only be studied in a laboratory, while for others the use of a fully equipped telegraphic or wireless station is necessary.

8. As the result of our second inquiry, we ascertained that both in the United States and in Germany the State makes more liberal and extensive provision than is made by the State in this country for research and experimental work in wireless telegraphy.

9. In the United States this work is undertaken by three distinct departments, namely, the Navy, the Army Signal Service Corps, and the Bureau of Standards, but in order to secure economy and co-operation all these departments are for purposes of laboratory research brought under one roof in the buildings of the Bureau of Standards.

10. In Germany the work is carried out by the Post-office in the Kaiserliches Versuchsamt, a building containing 30,000 square feet of floor space. The work undertaken in this building is not confined to wireless telegraphy, but covers the whole

range of electrical engineering as applied to telegraphy, whether ordinary or wireless, and telephony. It is under the direction of Dr. Strecker, assisted by a large and competent staff, the research work in wireless telegraphy being under the charge of Dr. Kiebitz and Dr. Breisig. Research work of importance in wireless telegraphy has also been conducted by Dr. Lindemann at the Reichanstalt in Berlin, and by Dr. Reich in the Naval and Military Radio-electric Laboratory in Göttingen.

11. It must be remembered that the scientific results of the research work undertaken by the State, both in the United States and Germany, are for the most part published, and this country benefits thereby.

12. A careful consideration of the above facts has led us to the following conclusions, namely:—

(1) That it is desirable to establish some body or institution to initiate and control research in matters of general principle which cannot conveniently be investigated in departmental laboratories, to co-ordinate as far as may be the work now undertaken by the Post-office, Admiralty and War-office, respectively, in connection with experiment and research in wireless telegraphy, so as to prevent work undertaken by one department overlapping work undertaken by another, and thus secure economy, and to discuss any difficulties arising in practice.

(2) That the work now being done by the departments should be continued and extended, opportunities being also found for the departmental engineers to carry out such experiments and tests as may be approved by the body or institution to be established for the purposes above referred to, and may require high power and service conditions.

(3) That it is desirable to establish a research laboratory as distinguished from the existing departmental laboratories and service stations—in which research work bearing on the practical needs of the services should be carried out under the guidance of the body or institution above referred to.

(4) That though the work to be undertaken by the new body or institution and in the new laboratory, the establishment of which we recommend, will principally concern wireless telegraphy, it is undesirable to exclude therefrom the problems of ordinary telegraphy and telephony.

13. In considering the lines on which the proposed new body or institution should be established, we have derived great assistance from the experience of the Advisory Committee for Aeronautics established in 1909. We understand that this Committee has worked smoothly and satisfactorily, and has fulfilled the purposes for which it was created, those purposes being in all respects analogous to the purposes which we have in view. The research work of this Committee is carried out in the National Physical Laboratory at Teddington, and we are of opinion that the new Research Laboratory for Wireless Telegraphy should also be worked in connection with that institution.

14. After careful consideration we have formulated and recommend the adoption of the following scheme, in which the word telegraphy is, except where the context otherwise requires, used to cover not only wireless telegraphy and telephony, but also ordinary telegraphy and telephony. The details of the scheme, including estimates of the probable expenditure, have been formulated by a Sub-committee* whom we appointed for the purpose.

## SCHEME.

15. The Government should appoint a National Committee for Telegraphic Research, whose duty it will be to promote generally in the public interest, both by theoretical investigation and by experiment, the progress of scientific telegraphy and telephony, and to co-ordinate and supplement the work now being done in the Government Departments interested in such progress.

16. The Government should establish a National Research Laboratory with a special scientific staff to undertake, under the direction of the Committee, and on the lines laid down in this report, telegraphic investigation, the results of which should be available for all Departments of the public service, and to co-operate with these Departments in dealing with the scientific aspects of practical problems arising out of service conditions. This laboratory should be established at Teddington in co-operation with the National Physical Laboratory, under the conditions hereafter specified.

### I.—THE NATIONAL TELEGRAPHIC RESEARCH COMMITTEE.

#### (1) *Membership of the Committee.*

The National Committee for Telegraphic Research should consist of twelve members, and be constituted as follows:—Two members representing the Admiralty, one member representing the War-office, two members representing the Post-office, two members appointed directly by the Treasury, three members appointed by the Treasury on the nomination of the Royal Society, one member appointed by the Treasury on the nomination of the Institution of Electrical Engineers, the Director of the National Physical Laboratory. The two members appointed directly by the Treasury should not be departmental officials, the Departments being sufficiently represented on the Committee in other ways. The Committee should appoint a secretary, and should also out of its own members select a president and a chairman. The secretary, in addition to possessing the usual qualifications for such a post, including a knowledge of French and German, should be a man of technical training and experience.

The appointment of each of the members nominated by the Treasury, the Royal Society, and the Institution of Electrical Engineers should be for three years, two of the six retiring in each year. A retiring member should be eligible for reappointment in cases where it is important that his services should be retained.

Of the six members nominated by the Treasury, the Royal Society, and the Institution of Electrical Engineers, two should in the first instance hold office for one year, two for two years, and two for three years. All subsequent appointments should be for three years.

Any vacancy should be filled on the nomination of the body which nominated the member whose vacancy has to be filled up.

No member of the Committee should give advice connected with telegraphy or telephony to any commercial firm on any matter connected with the work of the Committee, except with the consent of the Committee, and in any doubtful case such consent should not be given without the approval of the Department concerned.

Any member of the Committee who may act as adviser to any private firm or individual on any subject dealt with by the Committee or investigated in the Research Laboratory should notify the fact to the President of the Committee, and, if the President thinks fit, acquaint him with the nature of the advice he has given or may give from time to time. In any matter of importance which may be brought before the Committee it should be the duty of the president to call the attention of the Committee to the fact that one of their number is interested in his private capacity, and thereupon the Committee should have power, if it consider it desirable, to request the member in question to withdraw while such matter is being discussed.

* This Sub-committee consisted of Sir Henry Norman (Chairman), Sir Joseph Larmor, Dr. Glazebrook, Mr. Duddell, Rear-Admiral Charlton, and Commander Loring.

#### (2) *Duties of the Committee.*

The Committee should meet at regular intervals. It should be their duty—

(1) To consider generally and to promote by original investigation the progress of telegraphic research, to formulate schemes of investigation at the Research Laboratory or elsewhere, to supervise the consequent experiments, and to discuss the results.

(2) To consider problems submitted by the Departments and to arrange for experiments for their elucidation.

(3) To examine plans and designs for new methods and apparatus when submitted to them, and to report thereon if they see fit.

The Government Departments would continue to conduct, as now, researches or inquiries arising out of their own administration independently of the work of the Committee, and ampler provision for this purpose should be made in the departmental estimates. Where the results of these inquiries are of general interest they should, as far as possible, be communicated to the Committee for the advantage of other Departments interested.

The Departments concerned with telegraphic problems should, on the one hand, be entitled to the assistance of the Committee, and should, on the other hand, assist the Committee as far as possible in carrying out such researches as can most conveniently be made in their respective stations; but the head of each Department should have absolute discretion in deciding whether any scheme of experiment can be conveniently carried out at a station in his charge.

These departmental stations would include—

(*a*) The Admiralty wireless stations and experimental depôts.

(*b*) The Post-office Laboratory and wireless stations.

(*c*) The Army Experimental Section and such field stations as may be available.

With regard to these stations and the work done at them, the Committee would be in a purely advisory relation to the Departments.

The Committee should issue an annual report to be laid before Parliament. They should publish or authorise publication of such researches as they may consider useful for the advancement of science generally, and which are not of a confidential nature.

The Committee should have power in its discretion to organise or co-operate in international scientific investigations bearing on telegraphy.

### II.—THE NATIONAL RESEARCH LABORATORY.

#### (1) *Its Duties and Equipment.*

The Research Laboratory should be established with a special staff to carry on, under the direction of the National Committee for Telegraphic Research, scientific investigations in the methods of telegraphy, which have relation to the improvement of radio-telegraphic communication within the Empire or are otherwise useful in the public interest, and to assist the Departments in dealing with the scientific aspects of practical problems arising out of service conditions.

This laboratory should be established at the National Physical Laboratory at Teddington, under the conditions hereafter specified.

A suitable site for a mast with a small building attached exists in the paddock to the east of Bushy House, and at the proper time H.M. Office of Works should be approached with a view to obtaining permission for its use.

Arrangements should be made for erecting and equipping at the Laboratory the necessary new buildings and plant. The details of this work must, of course, be left for determination by the National Research Committee when constituted, and will depend largely on the particular scheme of research which such Committee may adopt.

The work of the National Research Laboratory should, however, be limited to research and experimental investigations. Routine testing and certifying should continue to be, as it now is, part of the normal work of the National Physical Laboratory, for which the customary fees would be paid to the Executive Committee of that institution. In cases of doubt as to whether work should properly be undertaken by the Research Laboratory or not, the National Committee should decide.

#### (2) *Its Staff.*

The National Research Committee should nominate the members of the staff, and these, when approved by the Executive Committee of the National Physical Laboratory, would be appointed by the latter as members of the staff of the National Physical Laboratory, and would be subject in all respects to its rules. They would be paid by the Executive Committee of the Laboratory out of funds placed at its disposal for the purpose by the National Committee. They would work under the direction of the Director, who would receive his instructions—as far as their work is concerned—from the National Committee.

There should be free interchange of assistance and information between the Research Laboratory staff and the departmental staffs with regard to any experimental work undertaken at the laboratory, in which the departmental staff is concerned. If thought desirable by the Departments and the National Committee, arrangements should be made for the members of the departmental staffs to work at the laboratory.

17. Besides formulating the foregoing scheme we have thought it desirable to estimate as far as we are able the expenditure which will be required in order to carry it into effect. For this purpose we have assumed that the expenditure necessary for research and experimental work undertaken by the Departments on their own initiative will be provided for, as is now the case, in the departmental estimates, but that the funds required for the work of the National Research Committee and the National Research Laboratory will be provided by the Treasury in the form of a grant in aid.

18. The probable expenditure for this work may be considered under the headings of probable annual expenditure and probable capital expenditure.

19. The probable annual expenditure will include (*a*) the honoraria, travelling, secretarial, and other current expenses of the National Committee; (*b*) the salaries of the staff and the current expenses of the Laboratory; and (*c*) the cost of experimental or research work initiated by the Committee at the departmental stations or elsewhere than in the Laboratory. The expenditure under (*b*) and (*c*) must depend largely on the particular schemes of work from time to time recommended or adopted by the National Committee. With regard to (*a*), we consider that the honoraria of members of the Committee may reasonably be fixed at ten guineas a meeting of the full Committee or of a Sub-committee appointed by it, the number of paid meetings per member per year not to exceed for the first two years fifteen, and after the first two years ten meetings. Such honoraria would not be payable to the departmental members, and in the case of the Director of the National Physical Laboratory should be paid to the Treasurer of such laboratory.

20. The probable annual expenditure under all three heads has been carefully considered by the Sub-committee, and on the footing that the honoraria of the members of the Committee will be as above indicated, and that all printing for the Committee will be done by the Stationery-office, they estimate such expenditure approximately as follows:—

| | £ |
|---|---|
| *Staff of Laboratory*— | |
| 1 principal assistant commencing at | 400 |
| 2 assistants commencing at £200 | 400 |
| 5 juniors commencing at £150 | 750 |
| 1 instrument maker | 125 |
| 1 assistant instrument maker | 100 |
| 2 laboratory boys at £50 | 100 |
| 1 porter | 80 |
| Secretary and clerk | 300 |
| | £2255 |
| Honoraria of National Committee | 1100 |
| Expenses of laboratory | 500 |
| Travelling expenses | 200 |
| Heating, gas, lighting, insurance, &c. | 245 |
| Cost of work assigned by the National Committee to the Departments | 500 |
| Total annual cost | £4800 |

21. The above estimate makes provision among the junior staff for a man who, without high scientific qualifications, has had experience in the erection of wireless stations, and in the designing, use, and testing of wireless plant, and also for a skilled operator, preferably an ex-Navy man, who would be necessary for the transmission and reception of wireless signals and for carrying out research communications with other stations. The estimate is also made on the assumption that much of the apparatus would be designed and made at the laboratory.

22. With regard to capital expenditure, this may also be considered under three heads:—(*a*) Mast, aerial, and earth connection; (*b*) buildings; and (*c*) equipment. Expenditure under all these heads will, of course, be a matter for the consideration of the National Committee, but we think it may be assumed that the National Committee will require—

(*a*) The erection of a single wooden mast, 150ft. high, with suitable antenna and earth connections.

(*b*) 1. A one-storey building near the foot of the mast, divided into three parts, one to contain the power plant, one the transmitting, and one the receiving apparatus. One room in this building would need to be metallically screened, to permit of the use of certain types of delicate apparatus. 2. A laboratory building, with a total floor space of 4000 square feet.

(*c*) Equipment on a scale suitable to the above.

On this assumption our Sub-committee has estimated the capital expenditure required at the outset as follows:—

| | £ |
|---|---|
| (*a*) The mast, &c. | 300 |
| (*b*) 1. The building at foot of mast | 1000 |
| 2. The laboratory building | 3000 |
| (*c*) Equipment | 3000 |
| Total | £7300 |

23. The above estimates have after full consideration been approved and adopted by all of us with this exception, namely, that Sir Alexander King and Mr. R. Wilkins consider that they are on a somewhat too liberal scale.

24. We have spoken of expenditure which will be necessary at the outset only. If, as is hoped, the work of the National Committee and the National Research Laboratory is found to be of great value, it is not improbable that the National Committee may recommend further expenditure both capital and annual, and to meet this contingency the buildings above referred to should be so designed as to be readily capable of enlargement. Even if the capital expenditure were increased by £3000, and the annual expenditure by £2000, the total cost, including departmental expenditure for the same purposes, would be less than the amount expended for similar purposes by the respective Governments of the United States and Germany.

25. We have also carefully considered the question of the form in which provision could be most appropriately made for the necessary expenditure. On this subject there is a difference of opinion between Sir Alexander King, Mr. R. Wilkins and Major Guest, on the one hand, and the other members of your Committee on the other hand.

26. Sir Alexander King, Mr. R. Wilkins and Major Guest are of opinion that this expenditure should be met, at any rate in the first instance, by a lump sum grant—payable by annual instalments—to cover a definite period, say, five to seven years, leaving the National Committee to consider and determine how the amount granted should from time to time be expended. In their opinion, the National Committee will have no direct incentive to economy nor any responsible head with whom the Treasury can discuss proposed expenditure, and they consider that these objections can only be met by a fixed annual grant.

27. The other members of your Committee take a contrary view. In their opinion the proposed National Committee should not be placed in the position of having to recommend and undertake such work only as can be met out of a fixed annual grant. It will be their business to consider and advise year by year what work in the way of research or experiment ought to be undertaken in the interests of national efficiency, and to estimate the probable cost of such work. The cost of work immediately and urgently required in the public interest might be in excess of the fixed annual grant, and if such work had to be postponed or abandoned for this reason, the usefulness of the National Committee might be seriously curtailed. It must be remembered that all the Departments interested in telegraphy will be represented on the National Committee, and it is almost inconceivable that the National Committee could recommend and estimate for work of which the Departments, through those representatives, did not approve. The Treasury could readily obtain full information as to all such work and the estimates in reference thereto, either from the National Committee itself or the Departments represented on such Committee. In the opinion, therefore, of all the members of your Committee—with the aforesaid exceptions—by far the better plan would be for the National Committee to prepare year by year a scheme of work which they consider to be desirable, and to forward such scheme to the Treasury, with estimates of the funds required for the ensuing year. The Treasury would consider these estimates, and if they were approved make provision accordingly. This is the plan which your Committee—with the exceptions aforesaid—recommend. It has, as we are informed, been adopted in the case of the Aeronautics Committee, and has very materially contributed to its success.

28. We understand that in the case of the Aeronautics Committee the grant in aid is paid into the National Physical Laboratory's account at the Bank of England, that all payments are made from such account by the Treasurer of the Laboratory, and that the Director of such Laboratory is responsible for the accounts. We recommend that, subject to the approval of the Treasury, the same plan be adopted in the case of the National Committee for Telegraphic Research.

29. Inasmuch as some time must elapse between the appointment of the National Committee and the completion of the building and equipment of the Research Laboratory under their direction, we have thought it desirable to consider whether some work on the lines we have suggested could not be usefully undertaken in the interval.

30. Among the subjects for investigation specified in the schedule to this report there are certain matters which require immediate attention. We may instance the following:—

(1) Researches into the methods of measuring and standardising electrical quantities under high-frequency conditions. Among these would be included measure-

ments of voltage, current, power, resistance, inductance, capacity, wave length, and decrement.

(2) Investigations into the methods of standardisation and construction of instruments such as condensers, inductances, resistances, wave meters, &c., and the determination of the losses in such instruments.

(3) A study of receiving circuits in general, including variations in type of inductances, condensers, detectors, telephones, relays and amplifiers.

31. The plant necessary for investigation into these matters would not, at first at any rate, be very extensive, and could, as we are informed by the Director of the National Physical Laboratory, be temporarily accommodated in the existing rooms of that institution.

32. We consider it possible that the National Committee may desire the opportunity thus afforded of commencing work before the new buildings are completed and equipped.

33. In order to commence work, however, it will be necessary that the National Committee should from the date of its appointment have the necessary funds at its disposal, and we have ascertained from the Treasury that there will be no difficulty in providing any funds that may be granted by means of a supplementary estimate in June or July of this year. We have carefully considered the amount which is likely to be required by the National Committee between their appointment and the end of the current financial year, assuming that the funds required for subsequent financial years will be provided in the Estimates for those years respectively. In our opinion, in order to allow this interim work to be begun with the least possible delay, and to secure that the necessary buildings and plant be erected and put in working order by as early a date as possible, it will be advisable that the National Committee should at once have at its disposal a sum of £4000, of which £1000 would be for the current expenses of the Committee, £1500 for the staff and current expenses of the interim work in the National Physical Laboratory, £500 for the purchase of plant for the purpose of such interim work, and £1000 towards the cost of the mast and aerial and the buildings connected therewith, which ought to be put in hand at once.

34. The consent of the Committee of the National Physical Laboratory will have, of course, to be obtained before the scheme we recommend can become operative, and if this scheme is accepted by the Government it would be well to approach such Committee for the purpose of obtaining such consent. Subject to questions of detail, we have satisfied ourselves that the scheme will be welcomed by the National Physical Laboratory.

35. We desire to add that the scheme and provisional estimates hereinbefore set forth have been submitted to and considered and approved by Lord Rayleigh, Sir Oliver Lodge, and Dr. Schuster, the Secretary of the Royal Society, and we have to thank all three for the valuable assistance they have given us.

36. We also desire to thank Colonel Squier, United States Military Attaché in London, Dr. Lewald, of the Ministry of the Interior, Berlin, and Dr. Strecker, of the Kaiserliches Versuchsamt, Berlin, for supplying us with information as to the research work in wireless telegraphy undertaken by the Governments of the United States and Germany respectively. We have also to thank our secretary for his services to the Committee.

PARKER OF WADDINGTON.
JOSEPH LARMOR.
HENRY NORMAN.
R. T. GLAZEBROOK.
W. DUDDELL.
ROLAND WILKINS.
EDWARD F. CHARLTON.
JOHN K. IM THURN.
A. F. KING.
W. SLINGO.
F. LORING.
HENRY C. GUEST.
JOHN S. FOWLER.
S. J. FARRER (*Secretary*).

SCHEDULE.

*Improvements in Methods of Measurement* of fundamental electrical quantities under high-frequency conditions.

*Transmitting Condensers.*—Measurement of efficiency of dielectrics used at different voltages, frequencies, and temperatures; quantitative results by which losses can be predetermined.

*Insulating Materials.*—Behaviour at high frequencies and voltages, and best methods of use.

*Receiving Condensers.*—Efficiency of different types.

*Transmitting and Receiving Inductances.*—Study of details of design with a view to minimising energy loss.

*Receiving Devices.*—Investigation of crystal and valve detectors under different conditions, and best methods of modifying these to obtain desired characteristics. Effect of variation of coupling between detector circuit and the rest of the receiving circuit. Effect of variation of inductance and capacity in receiving circuit. Methods of mounting and preparing crystals. Methods of amplification of received signals, both acoustic and electrical.

*Aerial Wires and Earth Connections.*—Measurements of losses due to brushing from different types of aerials at high frequencies. Measurement of decrement of aerial and earth system. Conductivity of different kinds of soil at high frequencies. Measurement of losses in steel plate earth connections. Measurements on model aerials to assist in design and to predetermine losses. Investigation of "earth antennæ."

*New Systems and Apparatus.*—Investigation of new systems of wireless telegraphy and apparatus employed therein, which may be submitted to the Committee and deemed by the Committee worthy of investigation.

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THE ALBERT MEDAL.—The Council of the Royal Society of Arts, with the approval of the President, H.R.H. The Duke of Connaught, have awarded the Albert Medal for the current year to Chevalier Guglielmo Marconi, D.Sc., LL.D., "for his services in the development and practical application of wireless telegraphy." The Medal was instituted in 1862 as a memorial of the Prince Consort, and is awarded annually for distinguished merit in promoting arts, manufactures, or commerce. The first recipient was Sir Rowland Hill, who received it in 1864; and the last his Majesty King George V., to whom it was presented last year.

ENGINE WASTE.—Owing to the very high cost of raw material during the last few years, it has been impossible to offer a clean waste at anything less than 30s. per cwt., with the result that a great deal of chemically adulterated waste has been sold. It has now been found that waste paper can be cut into threads, and so treated that it will be absorbent and blend with pure cotton waste, and so produce a perfectly clean article at a moderate cost. Paper, after being treated by the inventor, blends very easily with the cotton fibre, and, as a result, twice the bulk of pure waste is produced at nearly one half the cost. We understand that S. D. Stead and Son, of 24, Strand-street, Liverpool, are putting this new waste on the market, and they have sent up samples of a very excellent pure waste and of the shredded paper, but not of the new mixed waste, so that we are not, at the moment, prepared to express an opinion on its value.

## HADFIELD RESEARCH PRIZE.

WE learn from the May Bulletin of the American Institute of Mining Engineers that Sir Robert Hadfield, honorary member, has offered a prize of 1000 dols. for the best contribution to the publications of the Institute upon the general subject of "The Different Forms and Combinations of Carbon with Iron, including those in Iron Alloys." The prize will be awarded at the annual meeting of the Institute in February, 1916, to the best paper upon this subject which is presented to the Institute before November 1st, 1915, provided such paper is deemed worthy by the Institute's Iron and Steel Committee.

While it is not desired to define closely the exact lines or scope of the proposed research, as it is advisable to make these as broad as possible, the object in mind may be said to be generally as follows:—

To elaborate and find out the best methods of determining the forms of carbon in steel or iron, including those in iron alloys. A portion of the work would probably be a continuation of the researches which have in the past been carried out by Jullien, Abel, Muller, Ledebur, T. Sterry Hunt, Akerman, Arnold, Stead, E. D. Campbell, Hogg, Parry, Upton, and others.

In a generic way metallurgists now speak of carbides, subcarbides, double carbides, special carbides, and other combinations. It is very desirable that these should be accurately defined and understood. It is also desirable to know whether there are other or new forms; if so, can these be separated and their characteristics obtained.

It may be interesting to point out that the carbon compounds now definitely known are stated to number over 80,000. It is very probable, therefore, that there is room for much valuable and useful research to be carried out with the object of increasing our knowledge of the various combinations of carbon with iron, as probably some of these are still unknown.

In addition to research work upon particular forms of carbide which have not yet been determined, it is also desirable and necessary to determine the state in which the carbon exists. For example, there exists what is termed a "missing form" of carbon about which little is known or understood. More light is required about this form, as for many years very little has been added to our knowledge on this subject. It would be desirable, for example, to know whether the carbon not accounted for as carbide is "missed" in consequence of its being in so fine a state of division, or whether it is present in some special form or condition.

It may be mentioned as a general statement that when steel is in the austenitic condition it is softer than when transformed to the martensitic formation. In the former the carbon is considered to be in complete solution; yet steel showing martensitic structure is said to contain its carbon in complete solution also. If it could be shown that the martensitic formation results from the commencement of the falling out of solution of the carbon this would be of great assistance to all those who are desirous to have increased knowledge in this direction. It is therefore desirable to know exactly in what state the carbon exists in the austenitic and martensitic formations.

It is also necessary, if possible, to ascertain the molecular constitution of the carbides. Such a point has been raised by the able American scientist Professor E. D. Campbell, and much important research work has been carried out by him with regard to certain particular combinations or forms of carbide. In other words, is the ordinary carbide $Fe_6C$, $Fe_3C_2$, or is it some other combination? If so, what is its nature and molecular constitution?

The above seems to be an outline of the general direction which should guide those considering and taking part in this research. It is hoped that the results obtained will throw much light on the cause of the hardness of steel, also the nature and form of carbon combinations with iron and its alloys.

No special conditions are imposed as to the length of competing manuscripts (although diffuseness and repetition are always to be avoided), nor as to the number of investigators who may work together. No preference will be shown to Americans over investigators of any other nationality, nor to members of the Institute, nor to manuscripts in English over those in another language, but all will be judged upon the same terms. All manuscripts must be typewritten.

We are informed that a prize of similar value is being offered for competition in Great Britain and the Continent, and will be dealt with by the Council of the Iron and Steel Institute, 28, Victoria-street, London, S.W.

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## SUMMER MEETING OF THE INSTITUTION OF NAVAL ARCHITECTS.

CONSIDERABLE interest is being taken in the visit of the Institution of Naval Architects and also of the Institution of Engineers and Shipbuilders in Scotland to Newcastle-on-Tyne next month, when they will be entertained by the North-East Coast Institution of Engineers and Shipbuilders. Whilst the detailed arrangements are not yet finally completed, it may be expected that the attendance will constitute a record in the annals of the three Institutions, that the papers to be read and open for discussion will be of an exceptionally interesting character, and the hospitality extended to the visitors will be on a truly lavish scale. Altogether, the occasion will be a memorable one. The party will foregather at the Armstrong College on the morning of Tuesday, July 7th, for a reception of the Presidents, the Council, and members of the three Institutions, by the Right Hon. the Earl of Durham, K.G., and, after addresses of welcome by the Lord Mayor of Newcastle-on-Tyne and the Hon. Sir Charles A. Parsons, K.C.B., F.R.S., the President of the North-East Coast Institution, responses will be made by the Most Honourable the Marquis of Bristol, M.V.O., Rear-Admiral, President of the Institution of Naval Architects, and Dr. R. T. Moore, President of the Institution of Engineers and Shipbuilders in Scotland. The morning session will be devoted to the reading and discussion of four papers submitted by the Institution of Naval Architects. On that morning also there will be a reception for the ladies in the Assembly Rooms, Westgate-road, and they will afterwards travel by special train to Alnwick on a visit to Alnwick Castle, at the invitation of the Duke of Northumberland. Works visits are arranged for the afternoon, and in the evening a reception, to which ladies will be invited, will be held by the President, the Hon. Sir Charles A. Parsons, and the Council of the North-East Coast Institution of Engineers and Shipbuilders.

On Wednesday, July 8th, the morning session will be held in the Literary and Philosophical Society's lecture theatre, and it will be devoted to the reading and discussion of the following papers, submitted by the North-East Coast Institution:—"Some Notes on Warships Designed and Constructed by Sir W. G. Armstrong, Whitworth and Co., Limited," by Mr. J. R. Perrett; "A Review of the Progress in the Marine Steam Engine during the last Fifteen Years," by Mr. A. C. Ross; "Charging of Two-cycle Engines," by Professor B. Hopkinson, F.R.S.; and "A New Type of Internal Combustion Engine," by Mr. H. F. Fullager. The ladies accompanying the party will leave in the morning by motor cars, visiting some of the picturesque parts of Northumberland, and they will be the guests of the Lady Parsons at luncheon at Ray, Kirkwhelpington. Tea will be taken at Chollerford, and it is arranged that the party will return to Newcastle about 6.30 p.m. The afternoon of this date will be devoted to works visits, and in the evening there will be a reception and dance at the invitation of the Lord Mayor of Newcastle.

On the following day, Thursday, July 9th, there will be no reading of papers, as it is probable that journeys will be made by special trains to Sunderland to visit the engine works and shipyard of W. Doxford and Sons, Limited, or, alternatively, to Darlington, to visit the works of the Darlington Forge Company, Limited, and the members, along with the ladies, will meet in the afternoon at Lambton Castle, Chester-le-Street, to attend a garden party at the invitation of the Earl of Durham.

The morning session of Friday, July 10th, will be devoted to the reading and discussion of the following papers submitted by the Institution of Engineers and Shipbuilders in Scotland:—(1) "Influence of Varying Temperatures on the Strength and other Properties of Admiralty Gun-metal," by Professors A. Campion and John G. Longbottom; (2) "The Strength of Welds by the Oxy-acetylene Process," by Professor A. Campion and Mr. William C. Gray; and (3) "Some Experiments on a Diesel Engine," by Mr. W. S. Burns. In the afternoon a garden party will be held in Jesmond Dene, Newcastle, at the invitation of the Lord Mayor, and Sir Andrew and Lady Noble will be At Home to the Lord Mayor's guests at Jesmond Dene House, the grounds of which adjoin Jesmond Dene. In the evening the visitors will be entertained to dinner at Tilley's Rooms, Market-street, at the invitation of the North-East Coast Institution of Engineers and Shipbuilders, whilst for the ladies of the party there will be a reception by Mrs. Herbert Rowell at the Manor House, Jesmond.

For some time past, there has been a desire on the part of the municipal authorities of Newcastle-on-Tyne to pay tribute to Sir Charles A. Parsons' distinguished services to science and industry by conferring on him the honorary freedom of the city, and this ceremony is arranged to take place at 12.30 p.m. on July 10th at the Newcastle Town Hall, and accommodation will be reserved to those members of the party intimating a wish to be present.

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## LAUNCH OF A COAST DEFENCE BATTLESHIP FOR NORWAY.

COMPLETE success attended the launch from the Elswick shipyard on Tuesday afternoon, June 9th, of the coast defence battleship Nidaros, being built by Sir W. G. Armstrong, Whitworth and Co., Limited, for the Royal Norwegian Navy. It is interesting to note that the Nidaros is the eighty-fourth warship launched from the Elswick shipyard since its opening thirty years ago, and the fifth constructed there for the Royal Norwegian Navy. The keel of the Nidaros was laid on June 11th of last year, and she and a sister ship, the Bjorgvin, which is expected to be launched in about a month's time, are designated as coast defence armourclads, and they are considered to be admirably suited to the needs of the Norwegian navy.

They represent a development of their predecessors, the Harald Haarfagre and Tordenskjold, built in 1897, and of the Norge and Eidsvold, built in 1900. The displacement of the two first-named was 3450 tons, and the principal armament two 8.24in. guns and six 4.7in. The displacement of the second pair was 3847 tons, and the principal armament two 8.24in. guns and six 6in. guns. The displacement of the Nidaros and her sister vessel is 4825 tons, and the principal armament two 9.45in., four 6in., and six 4in. guns. The armoured waterline belt amidships is 7in. in thickness. The whole of the armour has been manufactured at Openshaw and the armament at Elswick. The machinery for all of the vessels aforementioned has been manufactured by Hawthorn, Leslie and Co., Limited, St. Peters, Newcastle-on-Tyne, and in the case of the present vessel the power of the machinery is expected to give a speed of at least 15 knots. In accordance with what is now a common practice at Elswick, the Nidaros was launched with all her main boilers and auxiliary machinery on board and funnel erected. Despite very inclement weather, a large gathering of invited guests assembled to witness the launch, the naming ceremony being performed by Madame Vogt, the wife of the Norwegian Minister. The vessel derives her name from the ancient city of Trondhjem, originally called Nidaros, founded in 997, and formerly the capital of Norway.

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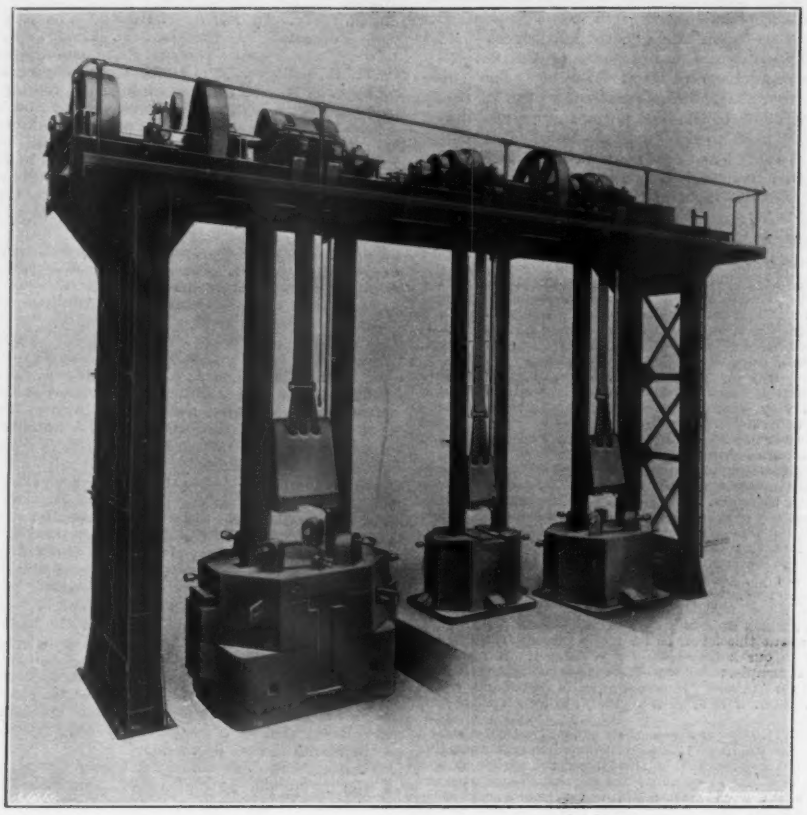
THE superiority of reinforced concrete for telegraph poles over the ordinary wooden poles established itself in the recent blizzard in New York. The *Engineering Record* reports as follows:—"The storm centre was in and about New York City. The wind blew at a velocity of eighty miles per hour, and there was a heavy fall of snow and sleet. As far as telegraphic communication was concerned, New York was isolated for several days. So severe a load did the ice-coated wires impose upon the concrete poles that the wooden cross-arms on some of them were broken. The poles themselves, however, remained intact." Photographs which accompany the above report show some wooden poles, after the blizzard, broken right through, whereas an illustration of some concrete poles shows these quite intact, excepting for the damage above mentioned.

# BATTERY OF FRICTION DROP STAMPS

B. AND S. MASSEY, LIMITED, OPENSHAW, ENGINEERS

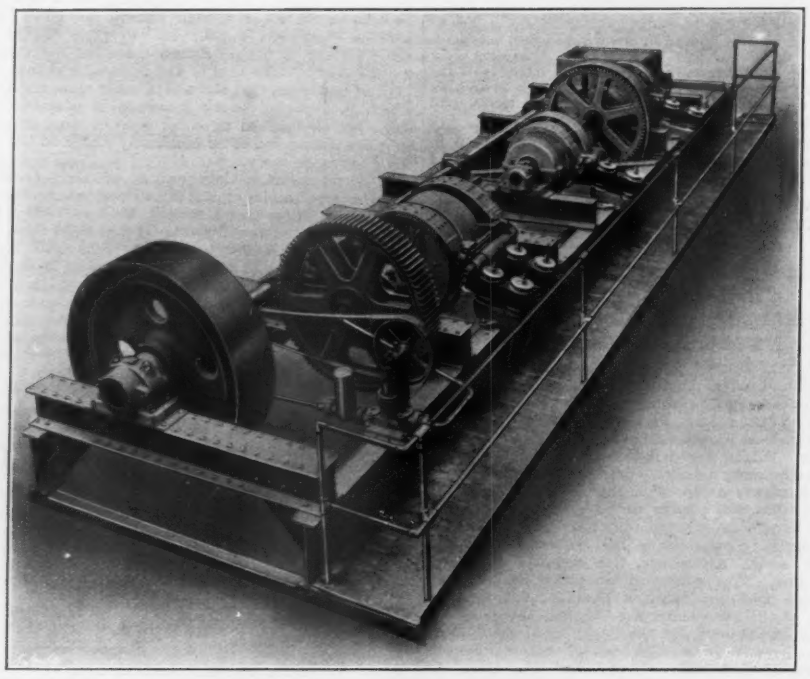


## FRICTION DROP STAMPS.

THE increasing tendency to use drop forgings of larger size is a noteworthy feature in many engineering works. Until a year or two ago stamps of a larger size than 20 cwt. falling weight were not used to any great extent, but friction stamps up to 4 tons falling weight are now in operation. The accompanying engravings show a battery of stamps of 60 cwt., 15 cwt., and 30 cwt. with the most recent improvements made by B. and S. Massey, Limited, Openshaw, Manchester. It will be observed that in the large stamp there are two lifting drums and bands between which the lifting arms and loose pulley are placed, a compensating arrangement being provided in order that each friction band shall take exactly half the weight. This device consists of a small shaft having excentrically formed ends to which the ends of the lifting band are attached. When the tension on one end becomes excessive the extra pull causes the shaft to turn slightly and to increase the pull on the other end, thus balancing the pressure on each drum.

For driving purposes batteries of large stamps are usually divided into two or more units. In the stamps illustrated there are two pinions on the back shaft, one meshing with a spur wheel on the 60 cwt. stamp and the other driving the shaft which carries the 30 cwt. and 12 cwt. stamps. This arrangement enables the heaviest unit to be operated at a slower speed than the others. The controlling arrangement is similar to that which we described in THE ENGINEER of September 27th, 1912. It is extremely sensitive, the movement of the tup following that of the hand. Two methods of dissipating the heat engendered by the friction bands are employed. For the larger sizes a small ram pump, shown in the illustration, and driven by means of a belt from the back shaft, is used. This pump causes a circulation of water from a tank through the drum and back again. The smaller lifters are cooled by means of a water tank, which is divided into two parts by a partition. Into one of these compartments a scoop dips at each revolution of the lifter and picks up water which passes into the interior of the friction drum. As the tup falls and the shaft rotates in the opposite direction the water flows through another opening into the second half of the tank. The two halves of these tanks are connected by pipes with a common tank.

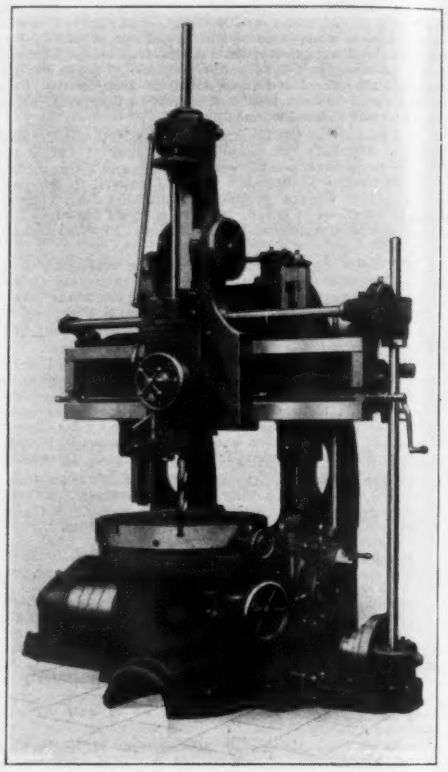
The amount of power used to operate these stamps is smaller than might be considered likely. We are informed that a 4 ton stamp in use in a large works in the North of England, when working fairly constantly, takes on an average 10 Board of Trade units per hour, which at a charge for current of 0.6d. per unit represents a cost of only 5s. per 10 hours' day. At another works a battery consisting of two 20 cwt. stamps with a 10 cwt. preparing stamp between them employing two sets of men, three in a set, and working harder than the large stamp just mentioned, costs about the same for power.



HEAD GEAR OF FRICTION DROP STAMPS

## VERTICAL BORING, TURNING AND DRILLING MACHINE.

THE annexed illustration represents a vertical boring and turning machine by George Richards and Co., Limited, Broadheath, Manchester, which has been specially adapted for drilling operations on water meter castings. It will deal with work up to 36in. diameter, 24in. high under the tool holder, and 30in. high under the cross slide. The latter is raised and lowered by power, and sliding upon it is a special head which carries the usual octagonal ram with a tool holder to suit square tools for turning. Passing through the ram is a drilling spindle 2½in. diameter, with a self-acting down feed of 18in. This spindle is driven independently of the table by means of a four-speed cone pulley and two-speed countershaft, thus giving eight speeds to the spindle, which has also four rates of feed. The spindle slide can be placed in any position on the cross slide for drilling holes any distance from the centre of the casting, which is mounted concentrically with the work table. The spindle slide is also balanced by the makers' spring balance arrangement, and the down feed can be operated whether the spindle is rotating or stationary. The head has automatic movement along the cross slide for facing, and the table has six holes drilled in its periphery, with a stop plug for engagement, for equally spacing the holes to be drilled in the work. The table can be rotated by means of a hand wheel through gearing for the purpose of bringing the work under the drill for each successive hole, and this gearing can be disengaged when it is required to use the machine for ordinary boring or facing work.



VERTICAL BORING AND TURNING MACHINE

## LOCOMOTIVES FOR WELSH RAILWAYS.

Two of the leading South Wales Railway companies have recently placed orders for new locomotives, but the one in which most interest will be centred is that of the Taff Vale Railway Company, which has contracted with the German firm, Hannoversche Maschinenbau-Aktien Gesellschaft vormals Georg Egestorff for six locomotives. This is the first time, it is believed, that an order has gone from South Wales to Germany, and the question as to how the engines will turn out is being much discussed in local engineering circles. The company declines to give any information with regard to the order, and all that is definitely known is that the engines have to be delivered this year. The price and question of delivery played an important part in the order going abroad. The order will mean an outlay of £18,000 to £20,000. The Barry Railway Company has also new locomotives on order. Two have been delivered and four more are due in the next six months. They are all of the G.W.R. type, and are intended solely for use for mineral traffic on the main line. These six engines will cost the company about £50,000. The Rhymney Railway Company had one out of three renewals delivered only last week, and the other two are due to arrive in the course of this month and next. The Rhymney Company has under consideration the question of having an exceptionally powerful locomotive built for mineral traffic purposes, but so far nothing definite has been decided, and probably will not be for some time.

# HIGH-POWER DIESEL ENGINES FOR MARINE SERVICE.*

By JAMES RICHARDSON, B.Sc., Assoc. M. Inst. C.E.

*Introduction.*—The present time would appear to be opportune for a review of the past achivements of the marine Diesel engine, so that a due consideration of those performances and a full realisation of the failures may throw light along the lines of development in the future towards increase of power per unit and the standardisation of a type more suitable to meet marine conditions.

*The Cycle of Operation.*—In considering future possibilities, only the two-stroke cycle will be dealt with, as the power of the four-stroke cycle engine is limited by the difficulties of dealing with the exhaust unless auxiliary exhaust ports be introduced, in which case the reason for retaining the four-stroke cycle would seem to disappear. These auxiliary ports have been applied to a fast-running four-cycle engine in order to permit of the escape of the high-temperature gases before the exhaust valve in the cylinder head opens. This method of exhaust will decrease the mean effective pressure of the expansion stroke, and may tend towards inefficiency of suction since at the end of that stroke these ports are again uncovered, and the quality of the suction charge may be affected. The gain in weight and space occupied with the two-cycle engine is not great, as will be explained later, especially when the extra fuel consumption, some 10 per cent., is considered, but, notwithstanding this, to obtain the maximum actual mean effective pressure per revolution the two-stroke engine will be adopted.

*Speed of Revolution.*—Apart from naval considerations, the speed of revolution of Diesel engines will always be relatively higher than that of steam engines, since the principle of the engine demands this to give flexibility as defined by the ratio of normal running speed to minimum running speed for a continuous period under suitable working conditions. Again, the accuracy of workmanship and the excellence of materials required by those parts subject to pressure and to temperature make it possible economically to run the oil engine at a relatively high normal speed of revolution.

*Piston Speed.*—The question of piston speed is not one of primary importance, and with two-stroke single-acting engines it is desirable sometimes that this speed should be such as to cause a certain inertia to permit of easier lubrication. Without this high inertia, of course, the pressure is always in the one direction upon all main bearings.

The stroke-bore ratio is determined by considerations of (1) ratio of combustion volume to cooling surface; (2) method of scavenging adopted; (3) limits of height of engine; (4) type of crank shaft, whether solid-forged or built-up.

Regarding No. 2, it may be briefly stated that valve scavenging permits of a large stroke-bore ratio, whereas port scavenging requires that this be kept relatively low, so that the air introduced through the cylinder wall ports may efficiently sweep out the products of combustion in the combustion space. Compare Nos. 1, 2, 3, 6, 7, 8, and 9 with valve scavenging with Nos. 13, 14, 15, and 16 with port scavenging in Table I. For naval work, of course, the height of the engine is limited, and for a given power a small stroke-bore ratio would be necessary. To permit of a built up crank shaft, making for a low first cost, a large stroke-bore ratio would be adopted. The question of the ratio of combustion volume to cooling surface should be carefully considered.

*Mean Effective Pressures.*—The mean effective pressure to be expected with two-cycle engines is to be seen from Table I.

TABLE I.—*Particulars of Slow-running, High-power, Two-cycle Diesel Engines.*

| Reference No. | B.H.P. | Revolutions per minute. | Cylinders per engine. | Diameter in inches. | Stroke in inches. | Ratio stroke, diameter. | Piston speed, ft./min. | M.E.P. on B.H.P. basis. |
|---|---|---|---|---|---|---|---|---|
| 1 | 1800 | 100 | 6 | 23.6 | 43.3 | 1.83 | 722 | 62.7 |
| 2 | 1500 | 130 | 6 | 20 | 36.2 | 1.80 | 782 | 67 |
| 3 | 800 | 115 | 4 | 20 | 36.2 | 1.80 | 695 | 60.5 |
| 4 | 1500 | 150 | 4 | 17 | 27 | 1.59 | 675 | 80.5* |
| 5 | 1800 | 200 | 4 | 17.7 | 22 | 1.25 | 735 | 82.5* |
| 6 | 750 | 120 | 4 | 18.125 | 32.25 | 1.78 | 645 | 74.5* |
| 7 | 2300 | 130 | 6 | 17.3 | 31.4 | 1.81 | 680 | 79 † |
| 8 | 3400 | 125 | 6 | 22.45 | 39.4 | 1.75 | 820 | 57.5 |
| 9 | 2000 | 90 | 6 | 24.65 | 47.3 | 1.92 | 710 | 65 |
| 10 | 2000 | 125 | 3 | 18.9 | 25.6 | 1.35 | 534 | 73.5‡ |
| 11 | 850 | 120 | 3 | 18.9 | 25.6 | 1.35 | 510 | 65 § |
| 12 | 750 | 200 | 6 | 14.5 | 24 | 1.6 | 800 | 62.4 |
| 13 | 1600 | 165 | 6 | 17.7 | 21.25 | 1.2 | 585 | 61 |
| 14 | 1700 | 160 | 4 | 18.75 | 27 | 1.44 | 855 | 70.5 |
| 15 | 1600 | 110 | 4 | 27 | 38 | 1.41 | 695 | 66 |
| 16 | 4000 | 132 | 6 | 29.5 | 39.4 | 1.33 | 865 | 74 ‖ |
| 17 | 1300 | 180 | 3 | 15.4 | 17.7×2 | 1.15 | 532 | 72 ¶ |
| 18 | 2200 | 150 | 4 | 17.3 | 20.5×2 | 1.18 | 513 | 75 ¶ |
| 19 | 800 | 120 | 3 | 15.75 | 15.75×2 | 1.0 | 315 | 72 ¶ |
| 20 | 2500 | 170 | 6 | 19.68 | 27.56 | 1.4 | 780 | 58 |
| 21 | 1000 | 140 | 4 | 21.65 | 31.5 | 1.45 | 788 | 61 |
| 22 | 1500 | 150 | 4 | 19.68 | 27.56 | 1.4 | 690 | 59 |
| 23 | 500 | 150 | 4 | 16.9 | 24 | 1.42 | 600 | 61.2 |
| 24 | 450 | 200 | 4 | 11.8 | 16.9 | 1.43 | 564 | 60.2 |
| 25 | 2200 | 130 | 6 | 24.8 | 35.4 | 1.42 | 540 | 65.5 |
| 26 | 2500 | 150 | 6 | 20 | 30 | 1.5 | 750 | 58.5 |
| 27 | 1000 | 150 | 4 | 21.75 | 31.5 | 1.45 | 790 | 56.5 |
| 28 | 1500 | 150 | 4 | 20 | 30 | 1.5 | 750 | 52.5 |
| 29 | 500 | 150 | 4 | 17.5 | 26 | 1.48 | 650 | 52.7 |
| 30 | 450 | 200 | 4 | 11.75 | 18 | 1.53 | 600 | 57 |

* Trial performance
† No. comp. on main engines.
‡ Double-acting. Trial performance.
§ Double-acting.
‖ Land engine.
¶ Double-piston engine.

The pressures given are for normal running, and are seen to average some 65 lb. per square inch on a brake horse-power basis where all the auxiliaries to the engine are driven by the engine. Trial performances give higher results, and land engines can be worked at a higher output. The double-piston or Junkers type, owing to the rapid compression, also has a high mean effective pressure. The limits are those of temperature and the means by which the mean effective pressure in the future may be augmented are:—(1) A higher overall efficiency of the plant by the injection of the fuel more economically with reference to the amount of high pressure fuel injection air required; (2) greater turbulence of the combustion air into which the fuel is injected, giving more spontaneous combustion; (3) artificial raising of the exhaust pressure against which the engine must exhaust, so automatically raising the scavenging air pressure and all the pressures of the cycle; (4) an increase in mechanical efficiency by accomplishing more work in the cylinder at an advantageous part of the stroke, although this would inevitably be accompanied by a loss of thermal efficiency; (5) rapid compression, permitting of the minimum amount of heat to be transmitted from the air to the cooling water through the cylinder walls on the compression stroke; (6) increase in the volumetric efficiency of the charge by means of the double-port method of scavenging, permitting the upper ports to charge the cylinder at a high pressure; (7) introduction of high-pressure air on the expansion stroke to permit of burning more fuel, and to give thus an overload.

In order to accomplish Nos. (1) and (4) of the above the author proposes the adoption of one or more fuel valves, the centre valve only requiring the use of highly compressed air for the injection of the fuel, and delivering fuel for sufficient power for the slowest speed desired, whilst the remaining valve or valves deliver the fuel against the lower pressure into the flame of the burning fuel delivered by the first valve. In this way the compressor capacity may be reduced, and, whilst retaining

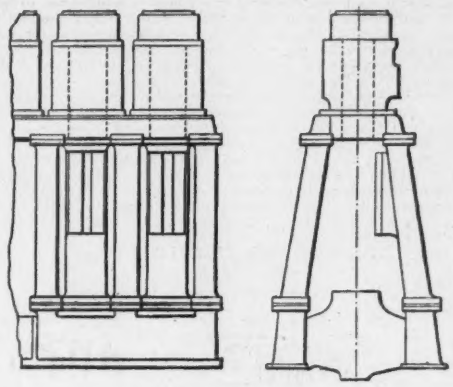


Fig. 1

the Diesel cycle for the one valve, the main fuel is separately ignited, and thus the work is done at a later part of the stroke and more advantageous conditions as regards mechanical efficiency are established.

Turbulence of the combustion air (2) is effected either by means of spiral spraying, such as is adopted with oil fuel burners for

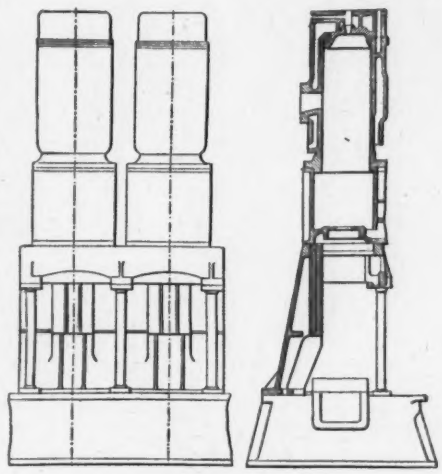


Fig. 2

boilers, or by setting the fuel valves tangential to an imaginary circle in the combustion space. To effect the artificial raising of the exhaust pressure (3) a throttle valve in the exhaust main is all that is required. Rapid compression (5) is attained with the engines of the Junkers opposed double-piston type.

*Load on Engine Parts.*—The cycle upon which Diesel engines work necessitates that the compression of air in the main

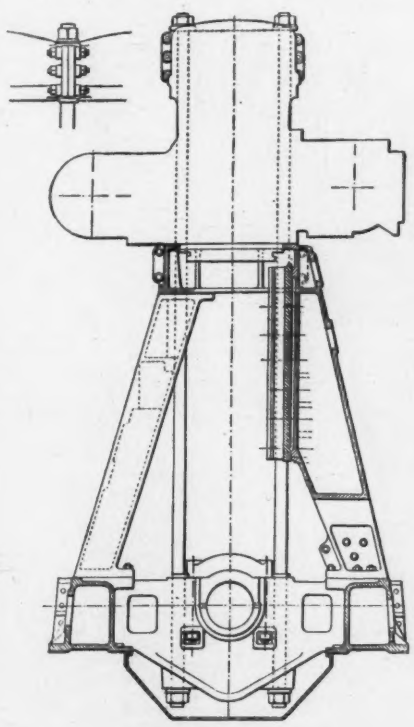


Fig. 3

cylinder shall generate sufficient heat for the immediate ignition of the liquid fuel as it is sprayed into the cylinder at or near the top dead centre of the engine. This compression pressure varies slightly with different sizes of engines, types of fuel, means of fuel injection, and forms of combustion space, but ranges from 430 lb. to 530 lb. per square inch, and is the cause of certain distinct phenomena which may be investigated.

Taking an average oil engine card with an inertia of 90 lb. per sq. in., and an average steam engine card, the running load on the main bearings at any point throughout one complete revolution reaches with the oil engine a maximum of 46,500 lb., with the steam engine of only 9500 lb. With the oil engine the rate of change of load is 920 lb. per deg. during 42 deg., whereas with the steam engine the maximum change is 90 lb. per deg. during 55 deg., or roughly one-tenth that of the oil engine throughout practically the same fraction of the revolution. The significance of these facts has reference to crank shafts and the general framing of the engine as well as, of course, to the question of cylinder strength, as not only must the actual amount of the load be considered, but also the rate at which that load is applied, *i.e.*, the rate of change of load which represents what is commonly known as shock. The reversal of load with the steam engine is of considerable importance when considering the question of main bearing lubrication as that reversal permits of the inflush of the lubricant. With a four-stroke oil engine, and even high-speed two-cycle engines, the conditions at suitable speeds of revolution would also show a reversal due to the inertia of the reciprocating parts.

Taking now the forces on the guide with the same cylinders as before, the total oil engine load is 10,500 lb., as compared with 3400 lb. in the case of the steam engine. The rate of increase affecting the rigidity and the materials of the framing in the oil engine rises rapidly, giving an increase per deg. of 304 lb. for a total of 50 deg. of revolution. With the steam engine the corresponding figures are 90 lb. per deg. acting throughout 20 deg. of revolution. With the oil engine the load is reversed, but with the steam engine it remains constant. This means that with the oil engine the shoes of the crosshead must be very carefully designed, constructed, and adjusted, so that at the reversal of load there is no shake from the one guide to the other. With steam engines this reversal may be experienced at low revolutions, when inertia effects are negligible.

If the engine be not of the crosshead type the piston clearances must be carefully watched to obviate the piston "slogging" from one side of the cylinder to the other, and the material must be such that the wear is not excessive. In certain cases with large trunk piston engines provision has been made for taking up side wear on the piston, but where such is necessary a crosshead should be provided if at all possible.

*Engine Framing.*—The engine framing takes the tension load due to the piston load and also the side thrust of the crosshead, and must be designed also to give to the engine the requisite degree of stiffness. In considering the latter, the question of balance of the engine must be taken into account.

The following leading types of framing are suggestive of the

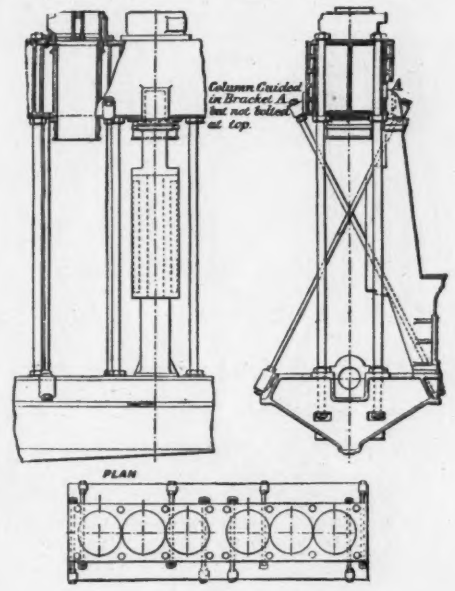



Fig. 4

lines upon which the high-power engine will be developed:—(1) The mercantile steam engine framing of cast iron columns at the back and the front of the engine—Fig. 1. A combination of cast iron columns with turned steel columns at the front, frequently adopted with steam engines, is shown in Fig. 2. (2) The cylinders supported on a cast iron framework for rigidity, whilst the piston load is taken by means of through bolts relieving the cast iron framing of tension stress—Fig. 3. (3) The engine carried entirely on a system of through bolts and turned steel columns suitably reinforced by bracing. In Fig. 3 the cast iron columns are introduced simply to carry the guides.

In this all-important question of type of framing, steam engine experience is, of course, invaluable, but lessons therefrom are in no way conclusive unless the pressure and load differences are thoroughly investigated and appreciated.

Whereas in a specified case with the steam engine the stress varies from plus 800 lb. to minus 600 lb. per square inch, with the oil engine the variation is from plus 370 lb. to minus 340 lb. per square inch for the same tension load. In this way the ratio of the bending to the tension load with steam engines is 0.15, compared with 0.082 with oil engines, showing that relatively the tension load is of greater importance in the case of the oil engine, and that, in consequence, the steam engine framing cannot be advocated for the oil engine with the same force as for the steam engine.

Partly in view of the foregoing, a system of taking the tension direct from the cylinder to the bed-plate would seem to be essential for large engines, not only from the point of view of the framing, but also from the point of view of the bed-plate. With cast iron columns taking the tension load, the bed-plate requires to be correspondingly stiffer, because the tension load must be transmitted from the columns to the bed-plate, and through the latter to the crank shaft by way of the main bearings. With through bolts, however, the tension load is taken from the cylinder direct to the bed-plate close to the main bearings, so relieving the bed-plate proper of considerable stress and reducing the bending moment in the cross-girders to about two-fifths of that without through bolts.

When the design of cylinder head permits, the spacing of the through bolts should be such as to reduce to a minimum the bending moment (*a*) between the seating and the through bolts, and (*b*) between the two through bolts. The advantages of this method in reducing the bending moment are obvious.

The construction of the future would seem to require through bolts, either from the cylinder head or the cylinder itself from above the exhaust and scavenging ports to the bed-plate in way of the crank shaft. Another very important advantage with through bolts to the cylinder head is the fact that the cylinder is relieved of all tension stresses. This forged steel structure may require to be reinforced by some form of cast structure for stiffness and to carry the guides; but to what extent and of

* The Junior Institution of Engineers, April, 1914. Abstract.

what nature it is difficult to foresee, as the question of vibration due to lack of balance is one best settled by experience.

In view of the number and variety of types of framing at present advocated and built, it may be inferred that the design of the future is an entirely open question.

*Crank Shafts.*—The strength of the crank shaft is to some considerable extent proportional to the strength of the crank webs, as failures with multiple crank shafts have most frequently occurred in this section. To estimate accurately the actual stress in a crank web of a multiple-crank engine is exceedingly difficult. The following formula for web thickness is suggestive, and gives limiting values for the web scantlings if a stress of 9000 lb. per square inch be taken for good quality steel :—

$$f = \frac{590\ D^3\ R}{b\ t^3} + \frac{196\ D^3}{b\ t} + \frac{T\ max.\ -\ (T\ max.\ d/8)}{b^2\ t}$$

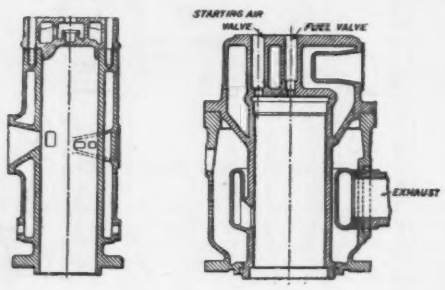
in which $f$ = stress, pounds per square inch.
D = diameter of cylinder in inches.
R = length of crank pin in inches.
$b$ = breadth of web in inches.
$t$ = thickness of web in inches.
$d$ = diameter of crank shaft in inches.
S = stroke of crank shaft in inches.
T max. = maximum turning moment, 63,030 brake horse-power × K/N.
N = revolutions per minute.
K = ratio T max./T mean.

This formula gives the summation of the three types of stresses in this part. The first term represents the stress due to the piston load acting directly through the crank pin. The second is merely that of crushing, and the third is that due to the transmission of the torque. For crank shafts of four or less cranks the first term is by far the most important, so that, roughly, the strength of the crank web may be stated as being proportional to $b\ t^2$.

Crank webs may be calculated upon the basis of the twisting of square shafts, but the data on this subject are very meagre. The strength of the crank web should, of course, be equal to the strength of the crank shaft, and if it can be stated that in usual Diesel engine practice the thickness $t$ is proportional to the breadth $b$, then $b\ t^2$ should be proportional to $d^3$, where $d$ is the diameter of the crank shaft and $t$ proportional to $d$.

For working out crank shafts to a first approximation, without taking into account the question of balance, method of drive of scavenging pumps, or whether the compressor is driven from the engine, the crank shaft rule of the British Corporation for the Survey and Registry of Shipping† works out very well for the great majority of cases.

*Cylinders and Cast Iron.*—Those parts which are subject to




Figs. 5 & 6

both temperature and pressure stresses—namely, the cylinder, cylinder head, and piston—form probably the heart of the problem associated with the development of high-powered Diesel engines. Not only is it a question of design, but more largely one of a suitable choice of materials, depending upon foundry practice and metallurgical research. An inspection of the various methods of attack of the problem of the design of these parts suggests at once to the observer that the solution is still distant, since nearly every maker of repute adopts an entirely different means to overcome these difficulties. The construction of the cylinder and head may be classified in the following manner :—(1) Cylinder and head in one piece ; (2) cylinder and head in two pieces—Fig. 5 ; (3) cylinder and head and liner, two pieces—Fig. 6 ; (4) cylinder, head, and liner, three pieces—Figs. 7 and 8 ; (5) cylinder and liner in one, two, or three pieces—Junkers. Under each of these headings great variations are again to be found. Before considering the relative merits of these systems, it is well to discuss the stresses to be withstood by the parts. First might be cited the casting stresses ; secondly, those due to the temperature differences in the various parts, *i.e.*, that of the combustion in the cylinder, the exhaust gases in their passages, and the cooling water in its spaces ; thirdly, the pressure stresses bearing throughout the cycle ; and, finally, any tension stresses due to the piston load being carried through the cylinder where through bolts to the cylinder head are not provided. These, taken collectively, make a formidable group.

Of these, the second stress, *i.e.*, that of temperature difference, is by far the most important, and for brevity the designs may be considered with reference to this alone. That in Class 1, which is suitable for small engines, gives immunity from trouble caused by leakage at joints, unequal expansions, and provides well for the passing of the heat of combustion into the cooling water. This application to cylinders of large diameter is impracticable on account of the obvious difficulties connected with dismantling, inspection and casting and the cost of renewal. Those in Group 2 —Fig. 5—have considerable advantage, but, as with those in Group 4 and the normal design of head, the cooling of the combustion space is not well provided for. With large cylinders the difference of expansion between the inner and outer walls in Group 2 might cause trouble. To overcome this one difficulty of cooling the combustion space some designers have adopted the type of construction shown in Group 3—Fig. 6—which has few other merits. The construction shown in Group 4—Figs. 7 and 8—with a suitable design of head, will probably be that of the future, and to this further reference will be made presently.

In order to realise the advantages of the construction in Group 4, the question of the type of head must be examined, and that shown in Fig. 9 is proposed by the author. In this design a steel plate takes the piston load, and either a dished-out forged steel or a cast iron element accommodates the valves—preferably of minimum number, such as is possible with port scavenging—and serves to enclose the cooling water. By this means the head is greatly simplified, the head cooling space is easily accessible for cleaning or for the insertion of coils or other cooling apparatus, and the form serves to give a lower engine and the maximum efficiency in the cooling of the combustion space. With this type of head it is also seen that the objection which may be raised to the clump of metal where the liner is pressed into the cylinder is not valid. Suitable provision is made to accommodate the valves and to preclude the possibility of leakage of the cylinder contents into the cooling water space. An advantage of this Group (4) is that to each part can be assigned

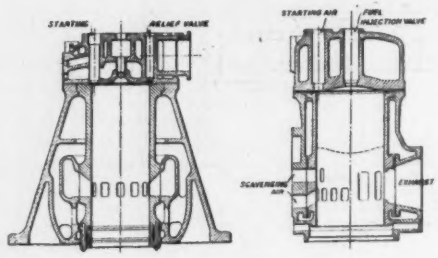
† At present this rule is, with other oil engine recommendations, before the Technical Committee of this Society for consideration and possible amendment.

the material most suitable for the functions to be performed, and the liner can be of the very best liner iron—harder than would be possible with an integral casting of cylinder and liner in one piece.

*Cylinder Head and Liner Materials.*—The question of the most suitable material for the head, cylinder, or cylinder liner and piston is a point regarding which no information has so far been published. Cast iron is now almost universally adopted for all these parts ; cast steel has proved unsuccessful for cylinder heads, pistons, and liners, due to its coefficients of expansion and modulus of elasticity differing from those of cast iron.

The conditions to be satisfied are primarily :—(1) Resistance to growth ; (2) high-tensile strength ; (3) hardness ; (4) shock-resisting properties ; (5) machining qualities. By growth is meant the deterioration of the structure of the metal, due to the rapid and large fluctuations of temperature to which it is exposed. The greater the tensile strength the thinner the wall required, and so the greater the transmission of heat from the combustion space to the cooling water. The greater the hardness compatible with machining the less the wear, and the smaller the allowance required therefor. Combined with these, the iron will have a high transverse figure and good shock-resisting properties.

Research regarding growth of iron of the qualities demanded




Figs. 7 & 8

by this work is so far inconclusive, but it can be stated, as a result of experiments carried out by authorities and by the author, that the iron should be a grey iron, of which the combined and graphitic carbons together exceed 3 per cent., roughly in the proportion of 0.5 combined to 2.5 graphitic carbon. In particular, this graphitic carbon should be of a close, small, and even structure, which makes, as explained later, for a reduction of growth.

Growth proper is increased by an open graphitic structure, permitting of the ingress of the high-temperature gases into the inner meshwork of the iron, and attacking probably the silicon, forming some combination of oxides of silicon. The ground work should be pearlite, and the phosphides should not in any way segregate, but should be evenly distributed. As already stated, the silicon is to some extent contributory to the growth, whilst a certain percentage is necessary to ensure good machining. This should be balanced by a suitable proportion of manganese, the ratio of manganese to silicon being not less than 1 to 1.4 ; in some cases 1 to 0.66 is attained. The effect of the manganese would seem to be to close the grain of the metal and so prevent the gases attacking the silicon.

However carefully and well the mixture of the iron may be specified as regards chemical composition, great care is required in the buying of the pig in order to give the desired results, and it is absolutely necessary that a cupola be set aside to cast this one mixture only. Foundry methods generally in this country do not lend themselves to an exact regulation of the iron.

*Scavenging.*—One of the most open questions at the present day is the best method to be adopted for scavenging the cylinder, which may be effected :—(*a*) By means of one valve in the cylinder head ; (*b*) two valves in the cylinder head ; (*c*) four valves in the cylinder head ; (*d*) one valve and the single-port method ; (*e*) the single-port method ; (*f*) the double-port method. The revolutions of the engine and the type of valves adopted for the scavenging pump are stated, so that in comparing the relative sizes of pumps an idea may be formed of the efficiency

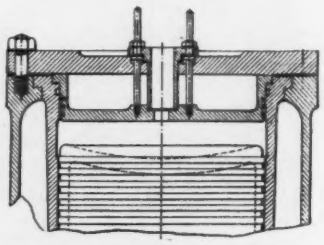


Fig. 9

of those pumps. For large engines of the future the methods likely to prove most advantageous are those of (*b*) two valves ; (*c*) four valves ; or (*f*) the double-port system. The one-valve method does not lend itself to the most efficient scavenging and to the attainment of the highest mean effective pressures ; similarly with the single-port method ; whereas the four valves in the cylinder head undoubtedly make for an undesirable complication, not only in the cylinder head casting, but with the driving gear for the valves, so that the two valves and the double-port scavenging systems would seem the most suitable.

As already mentioned, the double-port system of scavenging lends itself to the augmentation of mean effective pressure, to the simplification of the cylinder head, and also of the valve gear. As to the capacity of the pumps, great latitude, naturally, is possible, since the variables are as follow :—(*a*) Area of scavenging air inlet to main cylinder ; (*b*) time of opening for scavenging air to main cylinder ; (*c*) pressure of scavenging air desired ; (*d*) size of exhaust ports and back pressure of exhaust.

It will be seen that for two valves the ratio of about 1.5 is the mean, and for double port scavenging 1.75. The newness of this last method accounts probably for the high figure, and with greater confidence 1.6 to 1.65 will probably be found ample.

*Starting.*—The means universally adopted of starting marine Diesel oil engines of large power is compressed air, primarily because this medium is the most convenient.

In future the starting air storage, whether high or low pressure, will undoubtedly be reduced when (1) the confidence of experience is established ; (2) the regulation of the fuel is so made that the chances of an engine failing to pick up on fuel immediately, due to any derangement of the fuel injection pump valves or to any air in the fuel pump passages or pipes, is minimised ; (3) if some system of preliminary warming up of the engine be adopted. This last clause is by far the most important of the three, as, due to the slow compression at a low number of revolutions, a considerably greater amount of heat passes from the cylinder walls from the air being compressed in the main cylinder than will normally be the case, so that from this cause the compression temperature does not reach the normal. Further, the expansion of the starting air into the working cylinder from approximately the starting air pressure throttled to the exhaust pressure or that of the atmosphere, cools down the whole cylinder, and so further aggravates this starting difficulty.

The heating up of the starting air prior to its introduction into the cylinders is not exactly practicable, but the ensurance that the cylinders are hot before starting requires but a short time, is beneficial in preventing them from being subjected to unreasonable heat treatment, is easy of attainment, costs little, and would go far to reduce the starting air storage to a minimum. The tendency in the future will undoubtedly be to adopt low-pressure starting air systems for two-cycle engines on account of the aforementioned advantages. These systems will not be applied, as hitherto with such engines, by using the scavenging air pumps as the starting cylinders. This necessitates a greater strength of these parts, especially with large engines, than would otherwise be required, and entails also the pumps being connected to the main engines in a suitable manner for transmitting the starting torque. A probable method will be by relieving the compression pressure in the main cylinder, and so permitting of the required starting effort being given by air of considerably lower pressure than is at present adopted.

## FORTHCOMING ENGAGEMENTS.

THURSDAY TO SATURDAY, JUNE 11TH TO 13TH.

THE INSTITUTION OF WATER ENGINEERS.—Summer meeting at Stockport. For programme see page 578.

FRIDAY, JUNE 12TH.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. "Some Aspects of the American Democracy," by the Hon. W. H. Page, LL.D., the American Ambassador. 9 p.m.

PHYSICAL SOCIETY OF LONDON.—At the Imperial College of Science, Imperial Institute-road, South Kensington. "Note on the Connection between the Method of Least Squares and the Fourier Method of Calculating the Coefficients of a Trigonometrical Series to represent a given Function or Series of Observations," by Professor C. H. Lees, F.R.S. ; "A Magnetograph for Measuring Variations in the Horizontal Intensity of the Earth's Magnetic Field," by Mr. F. E. Smith ; "The Atomic Weight of Copper by Electrolysis," by Mr. A. G. Shrimpton ; "Note on an Improvement in the Einthoven String Galvanometer," by Mr. W. H. Apthorpe. 8 p.m. Editing Committee meeting at 7 p.m. Council meeting at 7.30 p.m.

SATURDAY, JUNE 13TH.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—In the Wood Memorial Hall, Newcastle-upon-Tyne. The following papers will be open for discussion :—"Stone Dusting at Bentley Colliery ; Report to the Doncaster Coalowners' (Gob-fires) Committee," by Mr. Robert Clive ; "The Automatic Distribution of Stone Dust by the Air Current," by Mr. H. W. G. Halbaum ; "Notes on Gob-fires and Blackdamp, &c.," by Mr. John Morris. The following paper will be read or taken as read :—"The Killingworth Colliery, New South Wales, Explosion," by Mr. James Ashworth. A mine-signalling apparatus and mechanical bells will be exhibited, described and demonstrated by E. C. Theedam, Limited. 2 p.m.

MONDAY TO SATURDAY, JUNE 15TH TO 20TH.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.—Nineteenth annual Convention at Birmingham. For programme see page 566.

WEDNESDAY, JUNE 17TH.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS, LONDON.—At Caxton Hall, Westminster. "The Evolution and Development of the Internal Combustion Railway Locomotive," by Mr. W. P. Durtnall. 7.30 p.m.

ROYAL METEOROLOGICAL SOCIETY.—70, Victoria-street, Westminster. Papers to be read :—(1) "The Rainfall of the Southern Pennines," by Mr. B. C. Wallis ; (2) "The Relation between Wind Direction and Rainfall," by Mr. H. J. Bartlett. 4.30 p.m.

TUESDAY, JUNE 16TH, TO FRIDAY, JUNE 19TH.

INSTITUTION OF GAS ENGINEERS.—Annual general meeting at Liverpool. For programme see page 620.

THURSDAY, JUNE 18TH.

CHEMICAL SOCIETY.—Burlington House, London, W. Ordinary scientific meeting. The following papers will be communicated :—"Nitrogenous Constituents of Hops," Mr. A. Chaston Chapman. "The Isomerism of the Oximes. Part IV.: The Constitution of the N-methyl Ethers of the Aldoximes and the Absorption Spectra of Oximes, their Sodium Salts and Methyl Ethers," Mr. O. L. Brady. "The Wet Oxidation of Metals. Part III.: The Corrosion of Lead," Mr. B. Lambert and Mr. H. E. Cullis. "Studies in the Camphane Series. Part XXXV.: Isomeric Hydrazoximes of Camphorquinone and some Derivatives of Aminocamphor," Mr. M. O. Forster and Mr. E. Kunz. "The Velocities of Combination of Sodium Phenolates with Olefine Oxides," Mr. D. R. Boyd and Mr. E. R. Marle. "Colouring Matters Contained as Glucoside in the Flowers of some Indian Plants," Mr. A. G. Perkin and Mr. I. Shurlman. "A New Chlorocamphor : Preliminary Note," Mr. T. M. Lowry and Mr. V. Steele. "Ideal Refractivities of Gases," Mr. W. J. Jones and Mr. J. R. Partington. "The Purification and Physical Properties of α-bromonaphthalene," Mr. M. Jones and Mr. A. Lapworth. "Determination of Water in Alcohol-water Mixtures by the Clouding Points of Mixtures with α-bromonaphthalene," Mr. M. Jones and Mr. A. Lapworth. 8.30 p.m.

SATURDAY, JUNE 20TH.

PHYSICAL SOCIETY OF LONDON.—Visit to the Cavendish Laboratory, Cambridge. The directors of the Cambridge Scientific Instrument Company have invited the Society to visit their works. Leave Liverpool-street Station for Cambridge, 9.10 a.m.; travel by special motor omnibuses to the works of the Cambridge Scientific Instrument Company, arriving at 11.10 a.m.; visit to colleges, &c., 2 p.m.; visit to Cavendish Laboratory, 3 p.m.; tea by invitation of Lady and Sir J. J. Thomson, 4.30 p.m.; meeting of the Society in the Cavendish Laboratory, 5 p.m.

SATURDAY, JUNE 27TH.

THE INSTITUTION OF MUNICIPAL ENGINEERS : EASTERN AND NORTH-EASTERN DISTRICTS.—12.45 p.m., assemble at Leicester (Midland) railway station, and proceed by conveyances on a visit of inspection to the Enderby and Stoney Stanton granite quarries. Arrangements will be made for blasting operations to be seen.

## THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

*(From our own Correspondent.)*

### Steel Prices Again Reduced.

THE expected has again happened in the steel trade. It is announced that the North of England steel makers have led off by bringing home prices down to the export level, and what the Cleveland makers have done, of course, the Staffordshire and Midland makers will have to do. It may therefore be taken for granted that steel plates this week stand reduced to country as well as shipping consumers 10s. per ton and angles 7s. 6d. per ton. Simultaneously the price of sections has been reduced 5s. per ton. The basis price for sections on contracts of 100 tons and upwards now becomes £5 17s. 6d., and under 100 tons £6. These prices, it is announced, apply to specifications received up to the end of next September for delivery by the end of the year.

### The Reduction Foretold.

The reduction of 10s. in steel plates and the drop of nearly as much in angles had been foretold. Three weeks back it was apparent to students of the steel market that it was becoming imperative to reduce home prices to the same extent as had been decided upon for the export trade early in May by the important joint conference of Scotch, North-East Coast, and Midland makers, then held. Home buyers would not enter the market with so great a difference as 10s. per ton in favour of export merchants against them. It was recognised that if business was to be placed upon a sound footing equal prices must be conceded to both classes of consumers. The deferred resolution has this week been made.

### Severe Continental Steel Competition.

The drop in country manufactured steel prices has come not a moment too soon. For the last fortnight or more it has been stated on Birmingham Exchange that the Belgians were getting much of the business offered locally in plates, angles, and sections. The continental competitors' quotations have been anything up to £1 lower than native Midland prices. Clearly, therefore, it is a self-defence move that our own makers have now taken, and a very wise one. Fortunately, neither the Belgians nor the Germans are at the moment able to take many orders away from the Birmingham market for steel half-products. The continental price for bars and billets is not now more than 2s. 6d. per ton, delivered into the Midlands, below native material. This margin is not large enough to turn the English consumer from local to imported raw steel. Bessemer steel bars are this week quoted £4 12s. 6d. to £4 15s. per ton, and Siemens bars £4 15s. to £4 17s. 6d. per ton.

### Pig Iron Better.

The pig iron outlook this week is a little improved. Inquiries have been made in some directions which are interpreted by makers as a sign that consumers are fairly convinced that prices have now touched bottom. Some of the bar iron makers have this week and last placed considerable orders for Derbyshire forge iron, and there is some little disposition to buy against future requirements. Smelters continue firm in their refusal to shade current rates, which have ruled for some time. Staffordshire common forge iron is quoted 48s. to 49s.; part-mine, 50s. to 51s.; best all-mine forge, 85s. to 90s.; Northampton forge, 47s. 6d. to 49s.; and Derbyshire forge, 51s. per ton.

### Interesting Foundry Iron Conditions.

There is a brisk demand for foundry iron, much better than for forge, and selling prices are relatively superior. It is regarded as a very satisfactory circumstance for the native iron-founding trade that during the period of stress through which the market is passing Midland smelters are able to offer foundry pig iron numbers at substantially lower prices than those ruling on the Continent. Thanks to the variety of the industries of this district, there is a good field for foundry iron producers hereabouts. It is a fact that Northampton foundry pig iron is now obtainable at some shillings per ton less than the corresponding grades of Belgian iron. This is so, notwithstanding that the Belgians have just taken 1s. per ton off their price in competition with the Luxembourg furnaces. Northampton foundry iron, delivered Birmingham, is quoted at date 51s. to 51s. 6d. per ton; Derbyshire, 53s. to 53s. 6d.; best all-mine Staffordshire foundry iron, 92s. 6d.; and Staffordshire cold blast iron, 125s. per ton.

### Finished Iron.

Nothing has occurred to stimulate the trade in galvanised sheets, which continue to show a drooping tendency. Buyers are apparently unprepared to pay the official price of £11 for 24 w.g. material f.o.b. Liverpool, and orders are being freely booked at £10 15s. and £10 17s. 6d. per ton. Black sheets are quoted:—Singles, £7 12s. 6d.; doubles, £7 15s.; and lattens, £8 7s. 6d. per ton. Notwithstanding the unsatisfactory prices ruling, the production of this class of iron is shortly to be added to by the opening of a sheet rolling mill in South Staffordshire by a maker outside the Association. Marked bars remain at £8 10s.; merchant bars, £6 10s. to £6 12s. 6d. delivered Birmingham; North Staffordshire bars, £7, delivered in the district; common bars, £6 2s. 6d. to £6 5s.; hoops, £7 5s.; and gas tube strip, £6 2s. 6d. to £6 5s. per ton.

## NOTES FROM LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

### Aftermath of the Holidays.

BUSINESS in Lancashire has not yet settled to its normal tone, and many well-known faces were absent from the Iron Exchange on Tuesday. The attendance was much below the average and demand for pig iron generally was at a very low ebb, with prices more or less nominal in character. There was little new to record in finished iron, but in steel and steel products, whilst ship plates were reported lower on the Tyne, it could not be ascertained that there had been any change in this centre. In copper, sheets, rods, and tough ingots showed a reduction, but there was no quotable change to note in tubes. Sheet lead and English tin ingots showed declines of about 10s. and £3 per ton respectively.

### Quotations.

Pig iron: Lincolnshire No. 3 foundry, 55s. 9d.; Staffordshire, 55s. 6d.; Derbyshire, 56s. 6d.; Northamptonshire, 57s. 6d.; Middlesbrough, open brands, 60s. to 60s. 8d. Scotch, nominal: Gartsherrie, 66s. 6d. to 67s. 6d.; Glengarnock, 65s.; Eglinton, 64s.; Summerlee, 66s. to 66s. 6d., delivered Manchester. West Coast hematite, 64s. 6d. to 65s.; East Coast ditto, 62s., both f.o.t. Delivered Heysham: Gartsherrie, 64s. 6d. to 65s. 6d.; Glengarnock, 63s.; Eglinton, 61s.; Summerlee, 64s. to 64s. 6d. Delivered Preston: Gartsherrie, 65s. 6d. to 66s. 6d.; Glengarnock, 64s.; Eglinton, 62s. 6d.; Summerlee, 65s. to 65s. 6d. Finished iron: Bars, £7 5s.; hoops, £7 12s. 6d. to £7 15s.; sheets, £8 7s. 6d. Steel: Bars, £6 7s. 6d. to £6 12s. 6d.; Lancashire hoops, £7 7s. 6d.; Staffordshire ditto, £7 17s. 6d. to £8; sheets, £9 to £9 5s.; boiler plates, £7 5s.; plates for tank, girder, and bridge work, £6 12s. 6d. to £6 15s.; English billets, £4 15s. to £4 17s. 6d.; foreign ditto, £4 5s. to £4 7s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, strips, &c., £77 per ton; small lots, 10d. per pound; rods, £75 per ton; small lots, 10d. per pound; tough ingots, £67 10s.; best selected; £68 to £68 10s. per ton; copper tubes, 9¾d.; brazed brass tubes, 9¼d.; solid drawn brass tubes, 7⅞d.; condenser tubes, 8⅛d.; condenser plates, 7¼d.; rolled brass, 7¼d.; brass turning rods, 6⅜d.; brass wire, 7½d.; yellow metal, 7¼d. to 7¼d. per pound. Sheet lead, £22 per ton. English tin ingots, £144 per ton.

### The Lancashire Coal Trade.

The effects of the holidays are still being felt on the Manchester Coal Exchange, and business in all departments could only be described as slow. There were some inquiries for house coal in view of the depleted stocks, but there was again no official change to note in prices. There was no change in the position of slack and engine fuel and shipping and bunkering coal. Quotations:—Best Lancashire house coal, 17s. 8d. to 18s. 10d.; good medium, 16s. 2d. to 17s.; domestic fuel, 13s. 5d. to 14s. 5d.; screened steam coal, 11s. 6d. to 13s.; slacks, 9s. to 10s. 9d. per ton at the pit.

BARROW-IN-FURNESS, Thursday.

### Hematites.

The condition of the hematite pig iron trade is one of steadiness. There is not much new business being done at the moment. The demand for iron is easy. On local account steel makers are again taking good deliveries of metal and shipments are fairly large, but the new contracts coming to hand are not big. Makers, however, still hold some good orders and are maintaining their prices, quoting 66s. to 67s. per ton net f.o.b. for parcels of mixed numbers of Bessemer iron. For special brands there is a steady request on home account, with now and again a little business done with continental users, who require it for high-class work. This iron is quoted at 72s. to 74s. per ton. There is no business in warrant iron, which is quoted nominally at 61s. per ton net cash. The output of iron is unchanged, there being fourteen furnaces in blast in Cumberland and eight in North Lancashire, five of these being at the Barrow Company's works.

### Iron Ore.

For the most part the iron ore trade is well employed, but at some of the pits there is rather a slackness. On local account the demand is pretty well maintained, and inquiries from outside the district are fairly strong. Good average sorts are quoted at 13s. 6d. to 15s. 6d. per ton net at mines, with the best qualities at 20s. 6d. per ton. For foreign ores there is a steady demand, and last week some 8000 tons of ore arrived from Almeria and Las Falaises. This ore is quoted at 16s. to 17s. per ton delivered to West Coast furnaces.

### Steel.

The steel trade is active again industrially. At the Barrow works and also from the Workington plant a steady output of steel rails is being maintained. The demand is somewhat easy, and not a deal of new business is being done. Heavy sections of rails are quoted at £5 17s. 6d. to £6 2s. 6d. per ton. For light sections the demand is on the easy side, also with the quotation returned at £6 7s. 6d. per ton. Heavy tram sections are a quiet trade at £6 7s. 6d. per ton. An order is now being dealt with at Barrow for Manchester. Hoops are in fair demand at £8 5s. per ton.

### Shipbuilding and Engineering.

These trades are very busily employed. The fitting out of the Turkish battleship Reshadieh is being pressed forward, but there is a lot of work yet to do before she can proceed on her speed trials. The British battleship Emperor of India is not so far advanced as the Reshadieh, but most of her machinery is placed in position and the deck and other work is proceeding. The three Brazilian river gunboats have not yet left Barrow.

### Fuel.

There is a steady demand for coal, which is quoted at 15s. to 17s. per ton delivered for good steam sorts. East Coast coke is quoted at 19s. to 22s.; Welsh sorts at 20s.; and Lancashire coke at 18s. per ton delivered. East Coast sorts are the most used. Little Welsh coke is bought.

## THE SHEFFIELD DISTRICT.

*(From our own Correspondent.)*

### The Outlook Not Hopeful.

THE outlook in the iron and steel industry here is not very reassuring. With a few notable exceptions the larger firms appear to be fairly well employed just at present, but without doubt the feeling is not quite so hopeful as it was a few weeks ago as to the course of trade. Orders are, however, in most cases still coming forward in sufficient volume to keep the mills moderately well occupied, and in many instances, in view of the good times which have been recently experienced, the present relaxation is not being very seriously felt. On the other hand, those manufacturers here who for some time past have been prophesying a slump point to the manner in which business is now restricted as an evidence that their forecast was not without justification. It is still difficult to see how things may work out, but it is hardly likely that very much change in the position—at any rate, for the better—will occur until the autumn. By that time the outlook may be a good deal brighter. Even as things are Russia is a good customer, but there are grounds for believing that even larger orders may come to Sheffield from that part of the world before very long in the way of railway material particularly. Then, again, as I have pointed out before, there are huge railway schemes projected in China, and now that the revenue from the salt gabelle has shown such a splendid yield that the Five-Power Group is contemplating proceeding with an immense new loan to China on the security of that tax, it is quite possible this railway undertaking may be pushed on with. It is to the United States that a city like Sheffield looks for the first indications of improved trade, and there are now signs in that country that with the settlement of two or three outstanding problems of a political and financial nature and the realisation of the excellent crop estimates, things will take an upward turn. Canada is one of the gloomy spots so far as Sheffield trade is concerned, and it is possible that things may have to be worse there yet before they substantially improve, whilst the continued unsettled state of the Balkans is keeping back orders which are long overdue. Taking all these things into consideration, one is in the position of hoping for the best, whilst prepared for the worst.

### Round the Works.

Of individual firms, that of Vickers Limited, for instance, is as full of work as it can be, particularly in the armament departments, where orders are on hand in connection with naval works for Russia, Turkey, Spain, Italy, and other countries, as well as important contracts for the home Government, and the firm is also busy, amongst other things, on light steel work for aeroplanes and automobiles. The armament departments at other works are also very well employed, though it cannot be gainsaid that large quantities of finished steel, such as armour plate, intended, apparently, for abroad, are lying in the works, whereas in the ordinary way they would have been dispatched long ago. The reason for this is not clear. The steel furnaces are not being kept at their full capacity, but nevertheless some fairly large tonnages are being made on overseas contracts, including some for Yokohama. One firm has in hand a good order for rollers and links, used in connection with collieries, for Algoa Bay; another is to make quantities of saws for Yokohama, and a third files for Antofagasta. Large contracts for files and tools have been secured for Hong-Kong, Karachi, Rangoon, Singapore, and Bombay, and tools for Bluff, San Fernando, and Trinidad. Contracts for buffers for the Bengal and Nagpur Railway and for the Taff Vale Railway and for tires for Calcutta have been placed here.

### Bar Iron.

The South Yorkshire Bar Iron Association, at its monthly meeting on Monday—a week later than usual, in consequence of the Whitsun holidays—reported a slightly better condition of trade, though things are still in a very poor way for crown bars. It was decided to make no change in the basis price, which therefore remains at £7 5s. per ton. What is wanted is a fillip in railway wagon building, but of that there seems no immediate hope. Marked bars continue in demand.

### Pig Iron and Billets.

Hematite irons are for the moment rather weaker. Sellers, however, are not pressing the market, and consumers are restricting purchases to quite small lots as required, there being practically no forward business. West Coast ordinary makes can be bought for less than 73s., Sheffield, and special qualities are, in price, according to specification. East Coast mixed numbers are offered as low as 66s. 6d., or 1s. 6d. less than the figure at which they stood firm for quite a long time; but there is no particular life about the market, though at the time of writing there is rather an appearance of things firming up a little before very long. In common irons, Derbyshire and Lincolnshire show no appreciable change, but buyers keep strictly on the open market for light parcels, and one hears very little about renewals of contracts, many of which will be running out with this month. A number of furnaces are out or damped down and most of the iron made goes at once into consumption, stocks being low at makers' yards and at consumers' works. This inactivity, however, is quite in accordance with the feeling as to trade, and neither makers nor buyers wish to take a leap in the dark. Billets, both Siemens and Bessemer acid and the local hard and soft basic, are still feeling the keen edge of competition, the basic qualities having to face the dumping of cheaper continental stuff. Scrap is a quiet market.

### Fuels.

Steam coals are in fair demand, but as the output is now so large and constantly increasing some of the pits are not working more than four days a week. A considerable tonnage, however, is still in arrears on old contracts, and these, with new business booked, are likely to keep pits moderately well employed for some time to come. Prices for shipment keep quietly firm at about 11s. at pit. Coke is not in active demand. Best beehive is quoted at round about 10s. 6d., with special lots at lower rates, and patent is 10s. to 10s. 6d. at the furnaces.

### The Returns for May.

The Board of Trade returns for the past month are not very satisfactory figures from Sheffield's point of view. Compared with the corresponding period in 1913, machinery exports showed an increase of £130,910, but iron and steel fell by over three-quarters of a million sterling, and new ships by over a quarter of a million. Implements and tools were down, but the value of machine tools exported was rather higher, though the weight was lower. Cutlery was nearly £4000 down, a figure which about represents the decrease in exports during the month to both Canada and Brazil, though Germany increased her order from £1244 in May, 1913, to £8077 last month. Exports of bars, angles, rods, and shapes or sections to Canada fell from 5268 tons in May, 1913, to 880 tons for the past month, and the total steel exports, including railway wheels and axles (complete), tires and axles, ingots, billets, sheet bars, castings and forgings, were £20,395, compared with £28,119 in May, 1913. Although coal exports as a whole reveal an increase, those from South Yorkshire and adjacent coalfields, through the Humber ports, mark a falling off.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Cleveland Iron Trade.

EXTREME quietness so far as new business is concerned characterises the Cleveland pig iron trade just now. But though the volume of business passing is not large, there are substantial reasons for anticipating an upward move in prices so soon as the autumn demands set in. There is at present no real reason for a pessimistic outlook, and, although nothing in the nature of a boom is anticipated, everything points to a steady trade at an improving level of prices. An early advance in the current price of iron would certainly be welcomed by makers. During the course of the current year there has been a substantial adjustment in wages, railway freights, &c., owing to the lower level of prices, but there has been no corresponding relief as regards the cost of iron-making materials, and so long as medium furnace coke can command as much as 17s. 6d. per ton the makers of Cleveland iron can only manufacture at a loss. They are consequently adhering to their policy of restricting the output, and, as has been the case for some time, the whole of the iron manufactured is going into immediate consumption. Some ironmasters still threaten to put out more furnaces unless conditions improve, and are determined to keep the output only equal to the consumption so that stocks do not accumulate. In the past they have had bitter experience of the detrimental influence of heavy stocks, and there is little likelihood of pig iron ever being stored again to the extent it was some years ago. There is more probability, in fact, of the abolition of the warrant stores by the withdrawal of the whole of the iron held there. No. 3 G.M.B. Cleveland pig iron is 51s. 6d.; No. 1, 54s.; No. 4 foundry, 51s. 3d.; No. 4 forge, 50s. 9d.; and mottled and white iron, each 50s. 3d.—all for early delivery.

### Hematite Pig Iron.

There is quietness in the East Coast hematite pig iron market so far as new business is concerned, and little doubt exists that the undertone is revealing a decidedly weak tendency. It must be admitted, however, that the interrupted deliveries to many of the steel works owing to the holidays have had some impression on the market, but quite apart from this, there is nothing like the demand that was in evidence a month or two ago, and, taking into consideration the fact that the shipping season is now in full swing, the market conditions from a maker's point of view are very unsatisfactory. The price of East Coast mixed numbers has been lowered to 60s. 6d. for practically any delivery, and makers declare that further reductions in the price are impracticable, in view of the persistently high cost of fuel.

### Iron-making Materials.

The foreign ore trade shows little movement. There have been one or two inquiries, but they have not led to any business, consumers regarding current rates as excessive. The attitude of some sellers, however, is rather stiffer than otherwise, and the general quotation is unaltered at 17s. 6d. for best Bilbao Rubio of 50 per cent. quality. The position of the coke trade is even stronger than last week, and far from obtaining concession, as was hoped, consumers are actually faced with a general stiffening of prices. Thus 17s. 6d. is now the average price of good medium furnace coke, and with consumers reluctant to follow the advance business has been on the quiet side. The price of coke is certainly a disturbing factor to iron manufacturers, but the coal market is so strong that there is no dis-

position on the part of makers to press coke upon the market, and at the moment the demand probably exceeds the supply.

### Manufactured Iron and Steel.

The feature of the Northern finished iron and steel trades this week has been the reductions in the price of steel ship plates and angles, which will be welcomed by shipbuilders. Steel ship plates show a falling off of 10s., and steel ship angles are 7s. 6d. lower, the former being £6 and the latter £5 15s. per ton. The great bulk of the trade in steel is being done under specifications connected with contracts fixed some time ago. The rail trade is, however, showing more activity, and most of the mills have work in hand to keep them busily employed until well into the autumn. This week a Teesside firm booked an order for 10,000 tons of heavy steel rails for Australia, and from the Midlands there is also an improving demand for joists and constructional steel. The London building strike, of course, still affects the joist trade, but with a settlement of that dispute there will undoubtedly come a good demand for constructional steel, to the benefit of the North-East Coast industries. The following are the principal market quotations:—Common iron bars, £7; best bars, £7 7s. 6d.; best best bars, £7 15s.; packing iron, £6 5s.; iron ship angles, £7; iron engineering angles, £7; iron ship plates, £6 15s.; iron girder plates, £7 5s.; iron ship and girder rivets, £7 5s.; steel bars, basic, £6 5s.; steel bars, Siemens, £6 15s.; steel ship angles, £5 15s.; steel ship plates, £6; steel engineering angles, £5 17s. 6d.; steel sheets, singles, £8 5s.; steel sheets, doubles, £8 10s.; steel joists, £6 12s. 6d.; steel hoops, £6 10s.; steel strip, £6 5s.—all less the usual 2½ per cent. f.o.t. Heavy steel rails, £6; steel railway sleepers, £7 5s.; light iron rails, £7—all net at works. Cast iron chairs, £4 5s.; cast iron pipes, 1¼in. to 2in., £6 7s. 6d.; 3in. to 4in., £6; 5in. to 8in., £5 15s.; 10in. to 16in., £5 17s. 6d.; 18in. to 24in., £5 17s. 6d.; cast iron columns, plain, £7 7s. 6d.; floor plates, £3 10s. to £3 12s. 6d., f.o.r. at makers' works. Galvanised sheet makers are experiencing much difficulty in securing new orders. The general quotation for sheets of 24-gauge is £11 5s. per ton, less the usual 4 per cent.

### Shipbuilding and Engineering.

The shipbuilding trade on the North-East Coast maintains its activity. The new orders recently placed are of importance, and will provide a large amount of additional employment. Various contracts have been recently arranged for providing additions to prominent ocean lines, and orders have also been received for smaller craft, such as colliers, &c. Marine engineers are briskly employed, and they have the prospect of a continuance of active times, while boilermakers as well as firms engaged in the supply of auxiliary machinery are also sharing in the prevailing activity.

### Coal and Coke.

An exceptionally strong tone characterises the coal market, though there has been some irregularity in the position, due to some extent to a dearth of ready tonnage. In several instances collieries have found some difficulty in making shipments. Best Durham gas coal is quoted around 13s. 3d., and second qualities from 12s. 3d. to 12s. 6d. There is a plenitude of coking unscreened coals, and, though the general quotation is 11s. 9d. to 12s. 6d., anyone with a steamer available could get a supply at a lower figure. The fairly heavy demand for Durham bunker coals is met with an ample supply, and ordinary qualities range from 11s. 9d. to 12s., while superior kinds are 12s. 9d. to 13s. The steam coal position continues strong, and the collieries ask 14s. 6d., and second hands 14s. 3d. Steam smalls continue firm at 8s. 6d. to 8s. 9d. for Blyths and 8s. 9d. for Tyne primes. There is still plenty of gas coke obtainable at 13s. to 13s. 6d., but foundry and furnace brands are scarce at 19s. to 21s. and 17s. 6d. to 18s. respectively.

## NOTES FROM SCOTLAND.

*(From our own Correspondent.)*

### The Warrant Market.

THE quantity of business transacted in the Glasgow pig iron warrant market during the past week is the smallest on record within recent years, the total amount being only 3000 tons. Owing to an entire absence of support, prices show a fractional falling off. Cleveland iron closed at 51s. 3½d. per ton cash buyers, and 51s. 4½d. one month, while the three months' price was 51s. 6d. per ton.

### Pig Iron.

There are seventy-two furnaces in blast in Scotland, compared with the same number in the preceding week and eighty-nine in the corresponding week of last year. Consumers show no inclination to contract ahead and business continues on quiet lines, but owing to the restricted output makers are disposing of their productions of ordinary qualities and hematite fairly well and stocks are low. Shipments of pig iron from Scottish ports amounted in the aggregate to 5841 tons, an increase of 802 tons compared with the same week last year. The import of pig iron into Grangemouth from Middlesbrough and district amounted to 7759 tons for the week.

### Quotations.

Monkland is quoted f.a.s. at Glasgow, No. 1, 62s.; No. 3, 60s. 6d.; Govan, No. 1, 61s.; No. 3, 60s.; Carnbroe, No. 1, 66s. 6d.; No. 3, 62s. 6d.; Clyde, No. 1, 68s.; No. 3, 63s.; Gartsherrie, Summerlee, Calder, and Langloan, Nos. 1, 68s. 6d.; Nos. 3, 63s. 6d.; Glengarnock, at Ardrossan, No. 1, 71s.; No. 3, 66s.; Eglinton, at Ardrossan or Troon, No. 1, 62s.; No. 3, 61s.; Dalmellington, at Ayr, No. 1, 63s.; No. 3, 61s.; Shotts, at Leith, No. 1, 68s. 6d.; No. 3, 63s. 6d.; Carron, at Grangemouth, No. 1, 69s.; No. 3, 64s. per ton.

### Finished Steel.

The unfavourable conditions which have been a feature of the Scotch steel trade for some time past still continue, and makers are finding it more and more difficult to keep their works employed. Specifications for plates are very scarce, and sectional makers are also suffering in this respect. There is very little business in the home market, and any orders passing are keenly competed for, while the demand for steel material for export is also limited.

### Steel Workers' Wages.

A meeting of the Scottish Conciliation Board was held during the week to consider the steel makers' application for a reduction in the workers' wages, in accordance with the sliding scale, which provides for the reduction when the prices of steel fall. It was decided to reduce steam workers' wages by 2½ per cent. The decrease will come into force immediately.

### Finished Iron.

Conditions in the various branches of the finished iron trade cannot be called encouraging. Black sheet makers are still fairly well employed and outputs are not yet seriously affected, but works are kept running with orders booked from day to day, which makers are finding increasingly difficult to obtain, and prospects are not promising. There is not the slightest improvement in the malleable iron trade. A week or so ago there was a drop in continental imports and makers were somewhat cheered thereby, but competition is now keener than ever and the position as hopeless as before.

### The Coal Trade.

The chief feature in the West of Scotland is the continued demand for splint coal, which is well booked for a week or two ahead. Business in ells is very quiet and best qualities have dropped to about 11s. per ton, with second qualities 9d. to 1s. per ton less. Navigation qualities are busy, but ordinary steams could be better employed. Smalls generally are more plentiful and somewhat easier. Business in the Lothians and the Fifeshire districts continues on much the same lines as in the preceding week. Collieries are well supplied with orders for most qualities, and though there has been a drop in shipments, this is largely accounted for by the fact that the miners' gala days were on for the first three days of the week and consequently a fair quantity of tonnage was detained. Tenders have been lodged with the Glasgow Corporation for the supply of coal for gasmaking purposes during 1914–1915. The Corporation's requirements are about 800,000 tons, and it is believed that prices will be about 1s. 6d. per ton beldw last year's quotations. The aggregate shipments from Scottish ports amounted to 279,976 tons, compared with 318,872 in the preceding week and 307,379 tons in the corresponding week of last year. Ell coal is quoted f.o.b. at Glasgow, 11s. to 11s. 3d.; splint, 10s. 9d. to 14s.; navigations, 14s. 6d. to 14s. 9d.; steams, 10s. 9d. to 12s. 9d.; trebles, 11s. 3d. to 11s. 6d.; doubles, 10s. 6d. to 10s. 9d.; singles 10s. to 10s. 6d. per ton.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### Cardiff Coal Market.

SOME attention has during the past week been called to future contract business by the announcement that the Italian State Railways Administration had arranged for the shipment between now and the end of the year of 100,000 tons of Pocahontas and New River coals, bringing the total quantity of American coals bought this year by the authorities to 300,000 tons. With homeward freights low the Americans are able to ship their "through the mine" coals to the Mediterranean several shillings cheaper than can be done with the coals usually taken from South Wales by the Italian State Railways, viz., leading Monmouthshires. In this particular case it is reported that the Americans have sold the coal at 2.50 dols., viz., 10s., and basing the freight to Genoa at 9s. 6d. this means a c.i.f. figure of 19s. 6d., whereas the current figure for best Monmouthshires is 17s. 6d. to 18s., and the freight being about 7s., the total cost is 24s. 6d. to 25s. Thus the Americans have a margin in their favour of about 5s. per ton. The Italian State Railways' authorities are making every effort to secure their requirements in the cheapest market, and are making extensive analyses of Scotch, Durham, and North Wales coals. This fact points to competition in the future being much keener between South Wales and other coalfields. The Americans have for some years made persistent efforts to get in South Wales markets, and occasionally succeed. They have this year made contracts with the Paris-Orleans Railway Company and the Paris, Lyons and Mediterranean Railway Company. Whether these spasmodic excursions on the part of the Americans into markets largely held by this district are to become permanent is difficult to say, but it is certain that once they have secured a good footing South Wales traders will find it a hard task to regain the ground lost. Local collieries which tendered for the supplies required by the Great Northern of Ireland Railway Company have been notified that their tenders have not been accepted. They were asked to send in prices for 55,000 tons of locomotive coals for delivery over six months, or 110,000 tons over twelve months. No one, however, seriously thought that this business would come to South Wales, inasmuch as a year or two ago the railway company adapted its locomotives for the use of Scotch coal, and therefore it is more than probable that their order for coal will again go North, although nothing so far has been heard as to the actual placing of the business. With regard to current business, the market has to some extent got over the disturbing effects of holidays, but business is slow to open out, and values are very strong for Admiralty coals, though for other descriptions there is a good deal of weakness prevalent. Outputs are beginning to get back to more normal figures, and tonnage supplies are improving. There has been a good demand for Admiralty coals for this month and next, but the short working last week and the fact that 2500 men at the Bargoed Colliery of the Powell Duffryn Company have been on stop for ten days up to Wednesday of this week—the strike now being settled—has restricted the quantity of coals available. There is some sign of the tightness slackening somewhat, though values are very slow to come down. Best Admiralties have been sold at 21s., and even higher figures are mentioned for the second half of this month. Buyers, naturally, were only prepared to buy their most pressing requirements, and to run the rest in the hope of easier conditions prevailing later. Whether the market will fall away to any appreciable extent is doubtful, as the Admiralty will commence shipping heavier quantities at the end of this month, in view of the naval review about the middle of July. Ordinary second qualities of Admiralties range about 18s. 3d. to 18s. 6d., though higher figures have been touched during the past few days. Drys have been steady, but Monmouthshires have been erratic. Small loals have been dullish, but have held up well on the basis of 11s. for best bunkers and up to 8s. 9d. for best cargo sorts. Patent fuel quotations are very steady, but pitwood, which now rules about 20s. to 20s. 6d., shows rather a tendency to weaken, supplies being plentiful and buyers scarce.

### Approximate Values.

Steam coal: Best Admiralty large, 20s. 6d. to 21s.; best seconds, 18s. 9d. to 19s. 6d.; seconds, 18s. 3d. to 18s. 6d.; ordinaries, 17s. 6d. to 17s. 9d.; best drys, 18s. 6d. to 19s.; ordinary drys, 16s. 3d. to 16s. 9d.; best bunker smalls, 11s. to 11s. 3d.; best ordinaries, 10s. 3d. to 10s. 6d.; cargo smalls, 8s. to 8s. 9d.; inferiors, 7s. to 7s. 9d.; washed smalls, 12s. to 12s. 6d.; best Monmouthshire black vein, large, 17s. 6d. to 18s.; ordinary Western Valleys, 16s. 3d. to 16s. 6d.; best Eastern Valleys, 15s. 9d. to 16s.; seconds, Eastern Valleys, 15s. to 15s. 6d. Bituminous coal: Best households, 19s. to 20s.; good households, 17s. to 19s.; No. 3 Rhondda, large, 17s. 6d. to 18s.; smalls, 12s. to 12s. 6d.; No. 2 Rhondda, large, 12s. 9d. to 13s. 3d.; through, 11s. 6d. to 12s.; smalls, 8s. 6d. to 9s.; best washed nuts, 16s. to 16s. 6d.; seconds, 14s. 6d. to 15s. 3d.; best washed peas, 14s. 6d. to 15s.; seconds, 13s. to 13s. 6d. Patent fuel, 19s. to 21s. 6d. Coke: Special foundry, 29s. to 30s.; good foundry, 22s. to 25s.; furnace, 17s. to 19s. Pitwood, ex ship, 20s. to 20s. 6d.

### Newport (Mon.).

During the past week Monmouthshire coals have been one of the weakest sections in the Welsh coal trade. The tonnage difficulty has been primarily responsible for the weak position of many collieries. Best black veins have kept up well and been firm at 17s. 6d. to 18s., but Western Valley and Eastern Valley large have been extremely irregular for prompt shipment. Towards the middle of the week the tonnage situation improved somewhat and imparted a steadier tone, but still the weak patches have not been eradicated, and values are hindered from making any appreciable advance. Small coals are weakish, the inquiry being slow. Current prices:—Steam coal: Best Newport black vein, large, 17s. 3d. to 17s. 6d.; Western Valleys, 16s. 3d. to 16s. 9d.; Eastern Valleys, 15s. 9d. to 16s. 3d.; other sorts, 15s. to 15s. 6d.; best smalls, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s. Bituminous coal: Best house, 18s. to 19s.; seconds, 17s. to 18s. Patent fuel, 19s. 6d. to 20s. 6d. Pitwood, ex ship, 20s. 3d. to 20s. 9d.

### Swansea.

The anthracite market has not shown the improvement in the demand usually expected at this time, and business being dull in all departments, prices are weak for prompt delivery. There is a rather better inquiry for July, but for this month the position is by no means satisfactory. Swansea Valley and red vein large are lacking in strength, and all machine-made coals are quiet. Rubbly culm keep firm, and a good tone is displayed for duff. Steam coals have also been inactive, and values are somewhat easy. Approximate quotations:—Anthracite: Best malting, large, 21s. 6d. to 23s. net; second malting, large, 17s. 6d. to 18s. 9d. net; big vein, large, 15s. 3d. to 16s., less 2½ per cent.; red vein, large, 12s. 9d. to 13s. 6d., less 2½ per cent.; machine-made cobbles, 21s. to 22s. net; French nuts, 21s. 9d. to 23s. 9d. net; German nuts, 21s. 9d. to 23s. 6d. net; beans, 15s. 9d. to 17s. 3d. net; machine-made large peas, 11s. to 12s. net; rubbly culm, 6s. 6d. to 6s. 9d., less 2½ per cent.; duff, 4s. 6d. to 4s. 9d. net. Steam coal: Best large, 18s. 9d. to 21s. 3d., less 2½ per cent.; seconds, 14s. 6d. to 15s. 6d., less 2½ per cent.; bunkers, 10s. 6d. to 11s. 6d., less 2½ per cent.; smalls, 8s. 3d. to 9s. 3d., less 2½ per cent. Bituminous coal: No. 3 Rhondda, large, 17s. to 18s., less 2½ per cent.; through and through, 14s. to 14s. 6d., less 2½ per cent.; smalls, 11s. to 11s. 9d., less 2½ per cent. Patent fuel, 17s. to 17s. 6d., less 2½ per cent.

### Tin-plate and Other Quotations.

I.C., 20 × 14 × 112 sheets, 12s. 4½d. to 12s. 6d.; I.C., 28 × 20 × 56 sheets, 12s. 7½d. to 12s. 9d.; I.C., 28 × 20 × 112 sheets, 24s. 9d. to 25s.; I.C. ternes, 28 × 20 × 112 sheets, 22s. to 22s. 6d. Finished black plates, £9 10s. per ton. Galvanised sheets, 24 g., £10 15s. to £11 per ton. Block tin, £138 17s. 6d. per ton cash; £140 15s. per ton three months; copper, £61 15s. per ton cash; £62 7s. 6d. per ton three months. Lead: English, £19 15s. per ton; Spanish, £19 10s. per ton; spelter, £21 10s. per ton. Silver, 2s. 4d. per oz.

### Iron and Steel Trades.

Pig iron: Standard iron, 50s. 10½d. cash, 51s. month; hematite mixed numbers, 61s. cash, 61s. 1½d. month; Middlesbrough, 51s. 3d. cash, 51s. 4½d. month; Scotch, 57s. 3d. cash, 57s. 4½d. month; Welsh hematite, 65s. dd.; East Coast hematite, 64s. c.i.f.; West Coast hematite, 66s. to 67s. c.i.f. Steel bars: Siemens, £4 11s. 3d. per ton; Bessemer, £4 10s. per ton. Steel rails, heavy sections, £6 2s. 6d. per ton. Iron ore, Rubio, 17s. to 17s. 3d.

## CATALOGUES.

FROM the Carron Company, of Carron, Falkirk, we have received a catalogue dealing with drop forgings. Also catalogues on wood-working machinery, ships' sidelights, patented saloon lights, &c., and steam steering gear, ash hoists, &c.

THE HOFFMAN MANUFACTURING COMPANY, Limited, Chelmsford.—A catalogue sent to us by this firm deals with ball bearings and steel balls. We have also received a small pamphlet entitled "How we get Hoffman Accuracy." Both publications contain much useful information.

A NEW catalogue on lever-balanced luffing cranes has been sent to us by Babcock and Wilcox, Limited, of Farringdon-street, E.C. With the aid of drawings the action of the lever-balanced gear is clearly explained and a great deal of useful and interesting information is given.

LAUNCH OF A NEW FLOATING CAISSON FOR THE LORDS COMMISSIONERS OF THE ADMIRALTY.—Swan, Hunter and Wigham Richardson, Limited, on June 8th, successfully launched from their shipyard at Southwick-on-Wear a floating caisson, which is being built for one of H.M. graving docks at Portsmouth. The caisson has a large draught of water, and was built and launched on its side. As soon as the caisson had been launched, it was towed to the wet dock at Sunderland, where it was uprighted. It will be completed ready for towing to Portsmouth in a few days' time.

CONTRACTS.—The Great North of Scotland Railway has just placed with Manning, Wardle and Co., Limited, of Leeds, an order for two special locomotives for the fish traffic at the new harbour works, Aberdeen.—The War-office has accepted the tender of J. C. Lyell and Co., Limited, 113, Great Portland-street, London, W., for a large "Auto" stationary type acetylene generating plant, patented improved safety back pressure valve and blowpipes with interchangeable nozzles, for oxy-acetylene welding.—The authorities of the city of Toronto have accepted the joint tender of the John verMehr Engineering Company, Limited, as engineers, and Wm. Cowlin and Son (Canada), Limited, as contractors, for the new mechanical filtration plant at Toronto Island. The contract includes, in addition to the pressure filtration plant, embodying Ransome continuous filters, the erection of the following structures:—Filter-house building, pumping station building, suction well building, chemical storage and mixing-house, coal storage building, wash water tank, chimney, wharf. It is, we believe, the largest single order ever placed for an installation of this description, the filters themselves being required to treat sixty million imperial gallons of water per day of twenty-four hours.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The last meeting of the session of the Institution of Automobile Engineers was held on the 27th ult., when Dr. A. M. Low gave a lecture on "Some Experiments and their Bearing on the Design of Automobile Parts." The line taken by the author was to advocate the study of the motion of the different parts of the car from the point of view of the actual parts themselves. He instanced the carburetter, which is adjusted with extreme care as to the weight of the float, &c., and is then fitted on an engine which is vibrating in such a way as to upset the accurate adjustments made. He stated that he had fitted an instrument which he termed the "Chattergraph" for observing the action of the brake shoe on the drum. This instrument showed clearly that the motion of the shoe in relation to the drum was a constant series of rotations of the whole drum with the shoe, alternating with a movement of the shoe in the drum. Dr. Low then pointed out that there were three methods of studying motion—the rotating mirror, the alternating generator with variable period, and the cinematograph. He strongly advocated the use of the cinematograph by automobile designers for the study of the motion of the various parts of a car and showed some experiments indicating the results which could be obtained. One of these experiments showed the action of a valve lifted by a cam, and the lecturer pointed out the bouncing of the valve off its seat with improperly shaped cams. He also gave the results of experiments on an induction pipe fitted with a glass window with two eye pieces and a shutter revolved by means of a cam from the engines. By this means the actual form of the globules of oil mixed with the petrol could be traced in various positions in the pipe. The author then dealt with the question of propeller flutter in aeroplanes, showing that this was entirely due to the impulses of explosion. He stated that a certain propeller, when driven with an electric motor showed a high efficiency, and that the same propeller when driven by a single engine showed an efficiency which almost reached vanishing point. He then sketched a form of pedal which would remain stationary relatively to the foot while being moved relatively to the body. The lecture concluded with a description of an apparatus which, though not connected directly with automobilism, was of great interest, the apparatus transmitting a picture from one place to another by means of wires only.

## NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

*(From our own Correspondent.)*

### Rheinland-Westphalia.

LITTLE is being done on home account in the pig iron industry. Deliveries of foundry pig have been well up to the average, and the Martin Works are reported to have sold their make till the beginning of July, but forge pig is in weak request. The tendency in the manufactured iron market has been a trifle less slow, and the mills have been asking better prices for forward sales. Basic bars realise M.2 to M.3 p.t. more than previously in the Rhenish-Westphalian district and the current quotation is M.94 to M.95 p.t., compared with M.92 p.t. a few weeks ago. Some works are reported to have asked M.96 p.t., but this is an exception. Dealers, on the whole, show very little inclination to pay more than is absolutely necessary, being well supplied till far into next quarter, and so the number of orders that can be taken in at advanced rates is very limited for the present. The export market remains without improvement. Offers from Belgian firms increase and export quotations have consequently been exceedingly low and unremunerative, more than M.80 p.t. f.o.b. Antwerp being obtainable with difficulty for basic bars. Accounts from the Luxemburg iron producing district have been a little less discouraging, and less than M. 81 p.t. free Antwerp is rarely accepted. The demand for bars is very quiet at present. In pig iron a moderate activity is reported, deliveries in foundry pig to Belgium having decreased. More life was felt in sectional iron owing to an improvement in the building department. A weak tone continues to characterise the Luxemburg iron ore market. Rates are lower than every before, and a rise cannot be looked for until the new contracts for 1915 have been booked, and even then only a slight advance will probably take place.

### The German Coal Market.

On the Upper Silesian coal market a reduction in output is being contemplated, because the general position seems to be going from bad to worse. Home demand has strongly decreased and this has led to a rapid rise in stocks. Since January this year deliveries per working day have shown a falling off, the railway requirements being smaller than previously, while the demand from the iron and zinc industry is moderate. A poor export only is being done to Austria-Hungary, owing to a rising output of some pits in Hungary, which are selling coal at very cheap rates. The sugar mills of Russian Poland have remained steady customers, but much less is exported to South and Central Russia than formerly. On the Rhenish-Westphalian coal market demand and consumption are stated to be limited and to show a falling off as compared with last quarter. Stocks of coke are heavy and increasing, and some coke ovens have been put out of service.

### Austria-Hungary.

The raw and finished iron industries are very poorly occupied and the general condition of the market is extremely quiet. Pit coal and brown coal have remained in tolerably brisk demand.

### Returning Strength in Belgium.

Since last week's report a change for the better has set in and the iron and steel market shows more life. Exports in bars have been so animated that the mills could realise higher prices. A few weeks ago buyers hesitated to pay £4 p.t., while now £4 5s. p.t. has been realised for basic bars. Several orders of weight were booked in at the above quotation, but makers do not care to dispose of their output for any length of time, because prices are now expected to move steadily upwards. Iron bars have not been touched by the rising tendency; they are firm at £4 8s. p.t. Rods stand at £4 13s. to £4 14s. p.t. Plates have also slightly improved; heavy steel plates for export stand at £4 14s. to £4 15s. p.t., while hoops are stiff at £5 15s. to £5 16s. p.t. On home account a quiet business is being done at 112.56f. to 115f. p.t. for basic bars, and 120f. p.t. for iron bars, while heavy steel plates stand at 125f. p.t. A moderate trade is being carried on in pig iron; forge pig is sold at 61f. p.t., basic stands at 65f. p.t., and foundry pig realises 66f. p.t. The weakness in semi-finished steel is more pronounced than ever; 70s. p.t. is the current quotation for rolled billets. The Belgian coal market keeps quietly steady.

## LAUNCHES AND TRIAL TRIPS.

DEMETERTON, steel screw steamer; built by Ropner and Sons, Limited, Stockton-on-Tees; to the order of Messrs. R. Chapman and Son, Newcastle-on-Tyne; dimensions, 429ft. long; to carry 10,000 tons; engines, constructed by Blair and Co., Limited; trial trip, May 26th.

ONA, twin-screw ocean-going tug; built by J. I. Thornycroft and Co., Limited; to the order of the Argentine Naval Commission for towing purposes; dimensions, 130ft. by 28ft. by 13ft. 11in.; engines, triple-expansion, 13½in., 22in., and 35in. by 27in. stroke, pressure 180 lb. per square inch; launch, May 28th.

MELANIA, steel screw steamer; built by Craig, Taylor and Co., Limited, Stockton; to the order of the Anglo-Saxon Petroleum Company, Limited, London; dimensions, 427ft. by 53ft. 4in. by 31ft.; to carry oil in bulk; engines, triple-expansion, 27in., 45in. and 74in. by 48in. stroke, pressure 180 lb. per square inch; constructed by the North-Eastern Marine Engineering Company, Limited, Sunderland; a speed of 11½ knots was attained, fully loaded, on trial trip, May 28th.

VARELA, twin-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the British India Steam Navigation Company, Limited, of London; dimensions, 390ft. by 53ft. by 26½ft.; to carry passengers; engines, triple-expansion, twin-screw; constructed by the builders; a speed of 16 knots was attained on trial trip, May 28th.

PANAMA TRANSPORT, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Furness, Withy and Co., Limited, for the Empire Transport Company, Limited; dimensions, 400ft. by 52ft. by 29ft. 6in.; to carry 8000 tons on a moderate draught; engines, triple-expansion, 25in., 40in. and 68in. by 48in. stroke, pressure 180 lb. per square inch; constructed by Richardsons, Westgarth and Co., Limited; a speed of 12 knots was attained on trial trip, June 4th.

HAIMARA, twin-screw passenger steamer; built by Philip and Sons, Limited; to the order of Crown Agents for the Colonies; dimensions, 100ft. by 23ft. by 9ft.; to carry passengers; engines, two sets compound surface-condensing engines, pressure 140 lb. per square inch; launch, June 4th.

ABELIA, twin-screw motor vessel; built by Sir W. G. Armstrong, Whitworth and Co., Limited; to the order of the Flower Motor Ship Company, Limited, London; dimensions, 350ft. by 46ft. 9in. by 27ft.; to carry 5600 tons; engines, two-cycle motor engines developing 1200 brake horse-power at 135 revolutions per minute; constructed by the Wallsend Slipway and Engineering Company, Limited; launch, June 5th.

VARSOVA, twin-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of British India Steam Navigation Company, Limited, of London; dimensions, 390ft. by 53ft. by 26½ft.; to carry passengers and cargo; engines, twin-screw triple-expansion; constructed by Swan, Hunter and Wigham Richardson, Limited; launch June 9th.

## BRITISH PATENT SPECIFICATIONS.

*When an invention is communicated from abroad the name and address of the Communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 8d. each.*

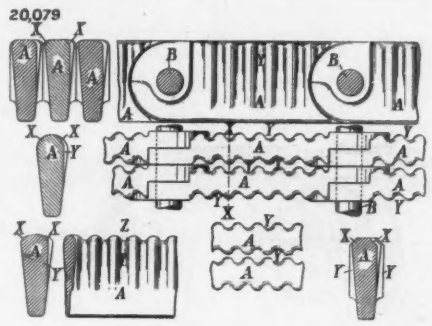
*The date first given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete Specification.*

*Any person may, on any of the grounds mentioned in the Act, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of any Patent.*

### STEAM GENERATORS.

20,079. September 5th, 1913.—IMPROVEMENTS IN CHAIN GRATE FURNACES, Edward Bennis, of Beech Hill, Astley Bridge, Bolton, Lancashire.

This invention consists in making the top surface of each longitudinal link rounded, curved or bevelled whether flat or corrugated at the sides to provide an air space beneath the layer of fuel and secure a better circulation or diffusion of the air through the fuel. The grate is built up of a number of longitudinal links A mounted on transverse rods B in the usual way. The top of each link A is made round or curved or flat on top with curved or bevelled edges X. The links A are, in addition to the curved, rounded or bevelled top, also preferably

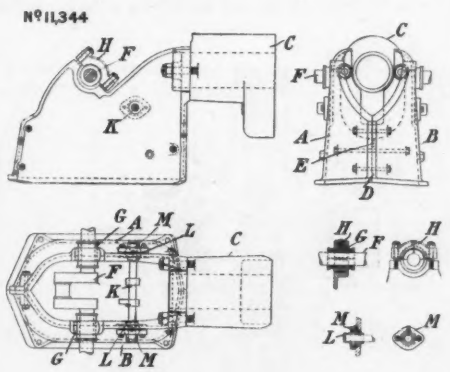



corrugated or fluted at Y at both sides, and in the direction of their length the links may be straight on top or corrugated as at Z. The side corrugations may be arranged relatively to one another, as shown. By thus constructing the longitudinal links A so that the edge Y where the air passes up to the fire is of rounded or curved shape or bevelled, it will not burn away so quickly as in the usual form of link. Moreover, the coal will be supported on a less area of the link and will offer less obstruction to the passage of the air to the fire and as a depression is formed between two links through which the air can pass, it will consequently reach a larger area of fuel. The corrugations serve a similar purpose.—*May 21st*, 1914.

### INTERNAL COMBUSTION ENGINES.

11,344. May 15th, 1913.—IMPROVEMENTS IN AND CONNECTED WITH THE BED-PLATES OR FRAMES OF INTERNAL COMBUSTION ENGINES, Edmund Ernest Bentall, engineer, and George Cowley Bingham, works manager, both of Heybridge, Maldon, Essex.

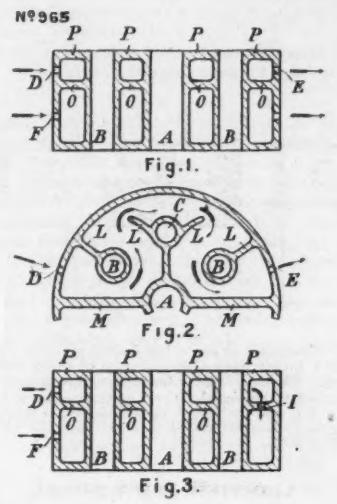
This invention has for its object improvements in the construction of internal combustion engines, designed to simplify the erection and adjustment and cheapen the manufacture thereof. The hollow open bed-plate or frame of the engine is formed in two parts A B, so shaped that they may be bolted together at both ends to form a rigid independent structure, and to this is bolted one end of the engine cylinder C. To render the joints between the two parts of such bed-plate or frame more secure and rigid, the abutting faces of these parts are provided with




V-shaped joints; those D at one end being situated at right angles to those E at the opposite end, as shown in full and dotted lines respectively. Transversely to the joint between the two parts of such bed-plate or frame is journalled the crank shaft F and this is provided with spherical bearings G, which rest on semi-cylindrical surfaces in the sides of the bed-plate or frame, and are secured in position by caps H, which are shaped to fit them and have bolt holes of sufficient size as to permit of adjustment. The half-speed shaft K is similarly journalled in spherical bearings L, which are arranged outside the bed-plate or frame and fit on to the ends of the spindle, and are held in position by caps M, which fit on to the bearings and are bolted to the sides of the bed-plate or frame, so that they are also capable of adjustment.—*May 21st*, 1914.

965. January 13th, 1914.—IMPROVEMENTS IN OR RELATING TO THE COOLING OF CYLINDER COVERS OF INTERNAL COMBUSTION ENGINES, Maschinenfabrik Augsburg-Nurnberg, A.G., of 7, Stadtbach-strasse, Augsburg, Germany.

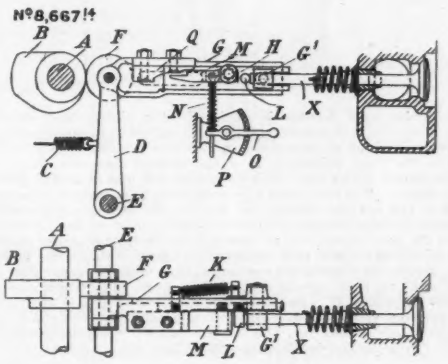
The cooling chamber of this cylinder cover, through which the piston-rod passes at A and the valves at B, is divided into two unequal parts by the partition O, and of these parts the upper part adjacent to the cylinder is considerably shallower than the other part. The cooling water, which enters at D and issues at E, and which comes direct from the pump or from the water supply conduit, will therefore flow through this chamber at a relatively high velocity. The lower cooling chamber is either fed from a separate supply pipe at F, or the cooling water that has traversed the upper cooling chamber can be caused to flow through the lower chamber by admitting it from the upper to the lower cooling chamber at I—see the lower illustration. The effect can be still further increased if a portion of the stream of water, after passing through the partition O, be circulated in such a manner that it flows as uniformly a




possible over the parts such as the valve and piston-rod sockets A, B and C, which pass through the interior of the cover. With this object in view, projections L—see the centre illustration—are provided in the cooling chamber, which render the cross section of the current of water substantially constant everywhere. The water then flows approximately as indicated by the arrows. In order still further to improve the cooling effect the upper cooling chamber in particular can be sub-divided by one or more partitions M. There are two other illustrations.—*May 21st*, 1914.

8667. May 15th, 1914.—IMPROVEMENTS IN VALVE GEAR FOR INTERNAL COMBUSTION ENGINES, Edmund Ernest Bentall, engineer, and George Cowley Bingham, works manager, both of Heybridge, Maldon, Essex.

The half-speed shaft A carries a cam B, which operates against the action of a spring C, the free end of a rocking arm D, which is mounted to rock upon a transverse spindle E and carries an anti-friction roller F, against which the cam B works. This rocking arm has hinged to it one end of a push frame G, which is supported at its opposite end by the engine inlet valve stem X by means of an eyed lug $G^1$ secured to the frame, and through which the valve stem works. The push frame G has arranged to slide in it a slide H, which is held in its normal position by a spring K, and is fitted with an extension or lug L, which engages and operates the inlet valve stem when the slide is caused to travel with the frame. This slide has hinged or pivoted to it a finger piece M, which swings in a vertical plane, and is normally held by a spring N against a cam surface on the frame. The lower end of this spring N rests on one end of a lever O, which is pivoted to a fixed plate P,



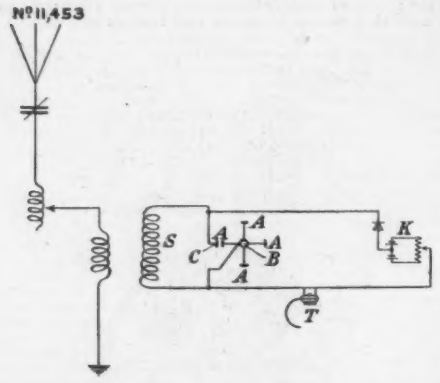

and has its opposite end arranged to move over and engage a serrated segmental projecting rib on the plate P, so that the lever may be adjusted to any position desired to vary the tension of the spring. The cam surface on the frame G comprises a combined curved surface and stop Q, and against this the finger piece M works in such manner that it will slide over the curved surface and engage the stop when the engine is running at normal speed, but when it exceeds this speed the finger piece will be thrown by the curved surface downwards to such an extent as to allow it to pass the stop, so that the slide will not be forced to travel with the frame, and consequently the inlet valve stem will not be operated as it normally is when the slide travels with the frame. The force with which the finger piece is thrown downwards and consequently the extent of its downward movement depends upon the speed of the engine and the tension of the spring N, so that by varying the latter the former may be varied as desired. The proper relative position of the slide H to the frame G at the commencement of each forward stroke of the latter is maintained by the spring K which connects together projecting lugs on said frame and slide.—*May 21st*, 1914.

### WIRELESS TELEGRAPHY.

11,453. May 16th, 1913.—IMPROVED MEANS FOR DETECTING CONTINUOUS ELECTRICAL OSCILLATIONS, Marconi's Wireless Telegraph Company, Limited, and Charles Samuel Franklin, electrical engineers, both of Marconi House, Strand, London, W.C.

A A are conducting sectors which can be caused to rotate about an axis B so that they approach and recede from a conductor sector C in series with an inductance S. The capacity between A and C thus varies between two limits, and therefore the tune of the circuit comprising the inductance S and condenser A C also varies between two limits, which can be made

as wide apart as desired by suitably proportioning A and C. This circuit is adjusted so that at one of the limits or at the intermediate position it is in tune with the aerial which is tuned to the wave it is desired to receive. The result is that the rectified current through a rectifier K during the reception of continuous waves is varied between maximum and minimum




values in a harmonic or any other desired manner, giving in the telephone T a very pure note, the pitch of which can be varied as desired. Obviously, an intermediate circuit may be introduced between the aerial circuit and the circuit S, and the condenser A C may be placed in this circuit or similar varying condensers—preferably geared together—may be placed in all the circuits.—*May 21st*, 1914.

## LIGHTING AND HEATING.

12,919. June 4th, 1913.—IMPROVEMENTS IN ELECTRIC ARC LAMPS, Adolf Harry Railing and Arthur Ernest Angold, 67, Queen Victoria-street, London, E.C.

This invention relates to improvements in electric arc lamps, and is applicable to the automatic cut-outs used in connection with the equivalent or substitutional resistances employed in arc lamp circuits where the lamps are arranged in long series. In such circuits disturbances, as, for instance, through the lamps pumping, may throw high voltages on individual cut-outs during the short time taken for the moving member of the cut-out switch to move from its "off" position to its "on" position. Should such voltage be high enough to cause an arc across the insulation of the cut-out and the lamp at a point where the arc would not be extinguished on account of its preventing the closing of the cut-outs, considerable damage will occur. The object of this invention is to provide means

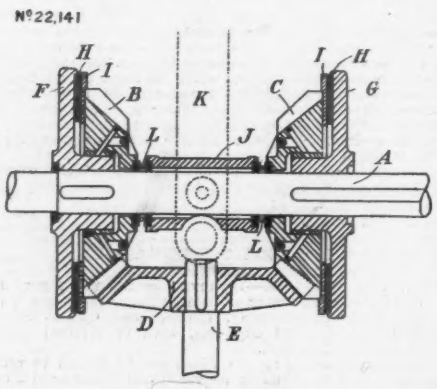



whereby such trouble is obviated in a simple and efficient manner. A is the spark gap, B and C are cut-out switch contacts, D is the equivalent resistance, E is the cut-out coil, F and G are the lamp terminals, H is the cut-out armature, K is the series coil of the lamp, L is the shunt coil, and M and N are the carbons. The spark gap A is arranged to be connected in parallel with the contacts B and C of the cut-out, and this gap is made shorter than the gap or distance across any of the insulation in the lamp or cut-out, so that any rise in voltage causes current to jump the spark gap, but as this current is compelled to pass through the equivalent resistance D, a voltage remains on the shunt coil E of the cut-out, energising its core, which attracts the armature H; therefore the contacts B and C are pulled together very rapidly, and consequently the arc across the spark gap A dies out, and in this manner complete protection to the insulation is afforded.—*May 21st*, 1914.

## CRANES AND CONVEYORS.

22,141. October 1st, 1913.—IMPROVEMENTS IN REVERSING GEARING FOR CRANES, Babcock and Wilcox, Limited, of Oriel House, 30, Farringdon-street, London, and Frederick William Hollick.

Running loose on the driving shaft A are two toothed bevel

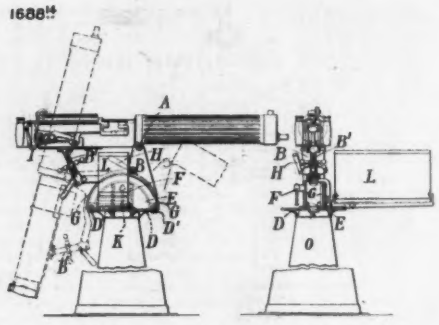



wheels B C adapted to mesh as usual with one bevel wheel D secured on the driven shaft E. The two bevel wheels B C are also loosely mounted on the hubs of two friction discs F G keyed to the driving shaft, one adjacent to the bevel gear B, and one adjacent to the bevel gear C. The inner face of each disc F G has a plane annular facing H of "Ferodo" or similar substance, while the bevel wheels B C are provided with co-operating plane annular metal facings I nearly contacting with the facings H on the discs. A sliding sleeve J operated by the usual clutch lever K is fitted on the shaft A between the bevel gears, and is adapted to act thereon through the intermediary of thrust bearings L, so as to press one or the other of the bevel gears B or C into frictional contact with its friction disc F or G, so that the reversing shaft may be driven in one direction or the other. Lubrication of the frictional bearing faces of the clutch above described is not required, and risk of involuntary slipping is avoided, while liability to seize or to render the action too sudden when the gear is used to check slewing action is overcome. Hence, the operations of slewing, luffing or travelling in cranes can be carried out with perfect safety. The gear may also be safely used in braking.—*May 21st*, 1914.

## ORDNANCE AND ARMOUR.

1688. February 11th, 1913.—IMPROVEMENTS IN OR RELATING TO AUTOMATIC GUN MOUNTINGS.—Sir Arthur Trevor Dawson and George Thomas Buckham, both of Vickers Limited, Vickers House, Broadway, Westminster.

This invention relates to automatic gun mountings of the pedestal type, and has for its chief object so to construct a mounting of this type that the gun can at will be converted from one for firing at the usual small maximum angle of elevation to one capable of being elevated to a high maximum angle for firing at aeroplanes or other aerial vessels. The pedestal is provided with a fixed training plate D, which is circular in plan, and is adapted to be engaged by detachable clips $D^1$ carried by a bracket E, which is formed with a socket to receive the

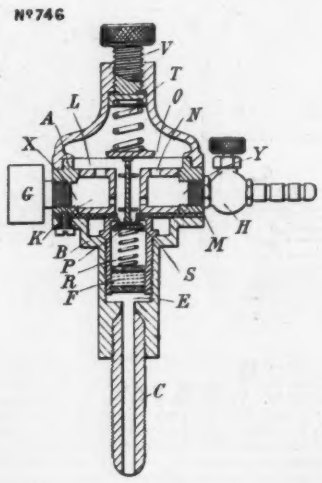



training pivot F carried by the training plate D. This bracket is provided with vertically arranged semi-circular guides G, upon which the top carriage B is mounted. This top carriage is forked to receive the trunnion pin A. The top carriage carries the usual elevating screw $B^1$ and a clamp H for retaining the top carriage in the required position. This clamp is normally in the engaging position, and the gun is then capable of being elevated by the screw. When it is desired to elevate the gun to a high angle, the clamp is released and the top carriage moved around the guides G on the bracket E. A suitable clamp K may be provided for co-operating with the training socket and the pivot E to retain the gun in any desired position of training. L is a cartridge belt box.—*May 21st*, 1914.

## MISCELLANEOUS

746. January 10th, 1914.—IMPROVED MEANS FOR PREVENTING THE FREEZING OF VAPOUR DURING THE DISCHARGE OF COMPRESSED GASES FROM STORAGE VESSELS, L'Air Liquide Société Anonyme Pour l'Etude et l'Exploitation des Procedes Georges Claude, of 48, Rue St. Lazare, Paris.

The present invention consists essentially in thermally insulating the portion of the expander containing the gas at high pressure from the portion containing the low-pressure gas. The cold produced by the expansion of the gas is then unable to communicate itself to the portion containing the gas at high pressure, and as the latter thereby preserves its temperature, all condensation and freezing are consequently avoided. The apparatus consists of two main portions A and B, the portion A receiving the expanded gas, and the portion B the gas at high



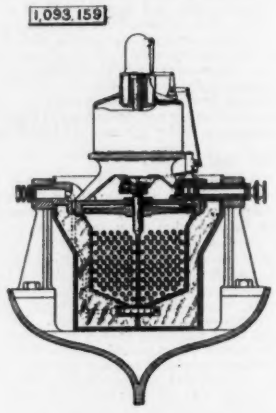

pressure. The gas enters through the threaded portion C, serving to connect with the oxygen cylinder and enters the recess E in which is housed the expansion member adapted to receive filtering-gauzes F and valve P, the latter being normally held to the seat S by a spring R. A plate M consisting of heat non-conducting material thermally insulates the part B from the part A in the most complete manner attainable, these two latter parts being connected by means of screws also surrounded by insulating material. A pusher receiving the movement of the membrane or diaphragm O serves to open the expansion orifice, and the regulation of the expansion pressure is effected by means of the spring T controlled by the screw V. The expanded gases enter the chamber K, and then pass through the passages N into the chamber L, thence the gases pass through the openings X and Y to the safety valve G, and the discharge cock H. During the operation of the apparatus the expanded gas, which is very cold, becomes distributed throughout the part A without having time to cool the part B; thus the high-pressure gas reaches the expansion orifice without any material fall of temperature, and, even if it is saturated with water vapour, no condensation can take place, the result being that the flow of the gas through the expansion orifice takes place with perfect regularity.—*May 21st*, 1914.

## SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette.*)

1,093,159.—TURBO SHIP-STEADYING DEVICE, *E. Thomson, Swampscott, Mass., assignor to General Electric Company, a Corporation of New York.—Filed September 19th*, 1913.

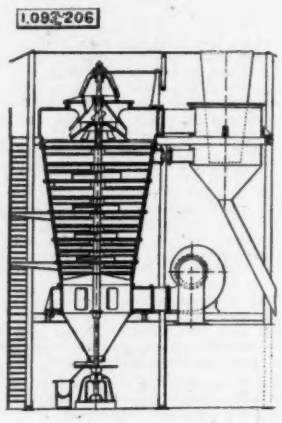
The anti-rolling device comprises a vertical shaft turbo-generator having a condenser base and tubular trunnions, the axis of which is athwartship for supporting it on an axis athwart the




ship. There are means for supplying steam to the turbine through one of the trunnions, and means for leading off the products of condensation through the other. The current produced by the generator may be used for propelling the ship. There are five claims.

1,093,206.—CONTINUOUS DRYING KILN WITH VERTICAL AXIS, *J. Réol, Alais, France, assignor to Société de Constructions Mécaniques d'Alais, Alais, France, a Corporation.—Filed December 24th*, 1912.

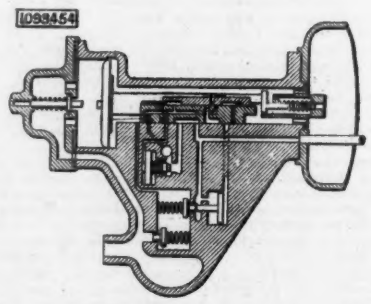
The kiln is vertical and has a central vertical spindle with a series of superposed, spaced platforms alternately arranged around the spindle. Vertical scrapers are provided upon each of the platforms and horizontal sections are secured to the scrapers,




while vertical ribs are secured to the underside of the platforms, forming at given moments an obturator with the sections for forcing the hot gases to pass through the falling material removed from the platforms by the scrapers in an automatic and continuous operation. There is only one claim.

1,093,454.—AIR BRAKE APPARATUS, *B. J. Minnier, Watertown, N.Y., assignor to New York Air Brake Company, a Corporation of New Jersey.—Filed November 1st*, 1909.

The apparatus embodies the combination of the triple valve cylinder and piston and main and supplementary valves operated thereby. A yielding stop overcomes a predetermined preponderance of train pipe pressure on the triple-valve piston, but is overcome by a larger preponderance. A restricting device co-operates




with the brake cylinder exhaust passage, and an operating piston therefor. Fluid pressure is provided to actuate the piston to bring the restricting device into operation, being admitted by the supplementary valve when train pipe pressure is sufficient to overcome the stop. An exhaust passage is provided which permits the restricting device to be inactive when the triple-valve piston is arrested by the stop. There are three claims.

## NOTES ON CENTRIFUGAL PUMPS.

By JAMES T. ROSSITER, M.I.E.E.

No. II.*

*Speed Factors.*—It is impossible to say exactly what takes place at the periphery of a rotating impeller, but for the purposes of calculation it may be assumed that the head H is produced by the velocity at the periphery $V_a$, and may be represented by the formula $H = \frac{V_a^2}{2g}$. In this case the speed factor is unity. The diagrams already given enable us to form some idea as to how $V_a$ is modified by the design of the pump. Figs. 4, 5, 6, 7, 8, and 9 show that altering the area of the passages in an impeller by letting the halves together alters the head characteristics, and consequently the speed factors. Thus, with 28.3 R.P.S. and a velocity $V_a$ of 81.5ft. per second an area of 12.6 square inches at the periphery produces a head of 103ft., an area of 8.72 a head of 99ft., an area of 3.7 a head of 92ft., whilst the same impeller completely closed produces a head of about 10ft. by friction alone. The speed factors represented by $\frac{\sqrt{2gH}}{V_a}$, being 1, 1.02, 1.06, and 3.2 respectively.

At the most efficient outputs the actual heads are 103, 96, and 80, and the corresponding factors 1, 1.037, and 1.14.

The curvature of the impeller blades and the shape and proportions of the conversion passages also influence speed factors.

Figs. 25, 26, 27, 28, and 29 give the ascertained speed factors of the pumps shown in Fig. 2, 10, 12, 21, and 23 respectively.

A description of the experiments may be of interest. To obtain complete speed regulation a liquid resistance with screw adjustment was connected in series with the shunt field regulating resistance of the direct-current variable-speed testing motor. Artificial head was obtained by throttling the delivery. Water measurements were made through calibrated orifices. The first set of measurements was made with the delivery valve closed, and the speed was adjusted to obtain the required heads. This gave speed and power readings on "open circuit." The next set was made with the delivery valve slightly open, and the speed was adjusted to obtain the same heads as in the first set. Quantity, power, and speed were noted, the opening of the delivery valve remaining constant. These operations were repeated until the pump was nearly "short-circuited."

With each successive opening of the delivery valve the quantity Q increased nearly as $V_a$, and the speed factor $f$ remained constant with constant delivery orifice, but with variable Q and $V_a$. When plotted it was found that Q and $V_a$ for each set of readings were straight lines radiating from a centre. These radiating lines, with their corresponding speed factors, are shown in the diagrams. In order to increase the utility of the diagrams speed factors for a given $V_a$ are also shown. It will be seen that the $f$ lines do not radiate from the zero of $V_a$, but at a $V_a$ the equivalent of the foot head. The importance of $V_R$ in connection with $f$ has been pointed out. $V_R$ has therefore been given in each diagram.

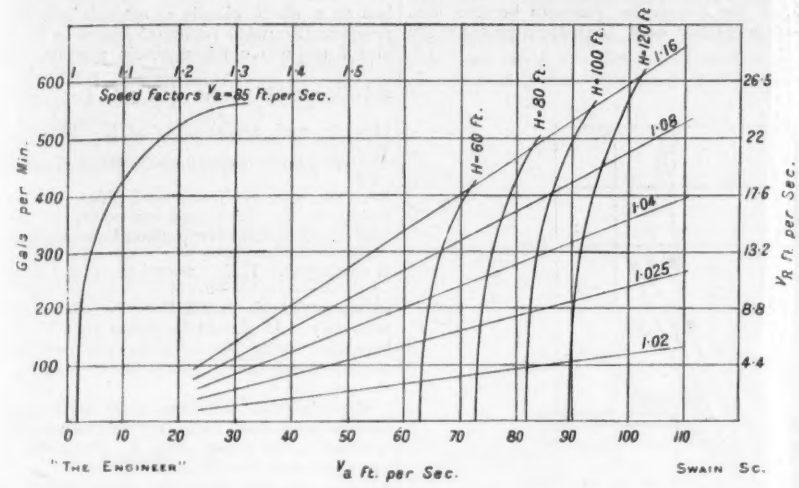



Fig. 25

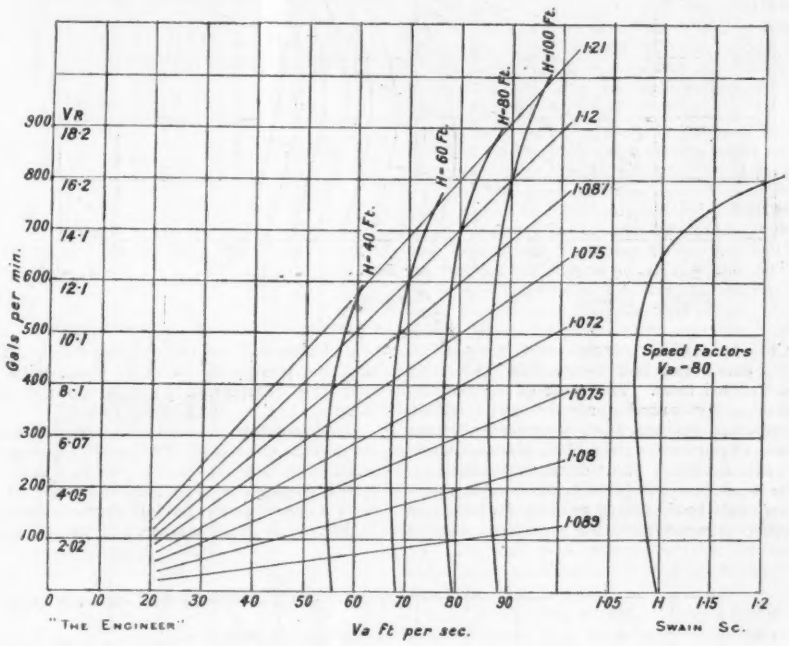



Fig. 27

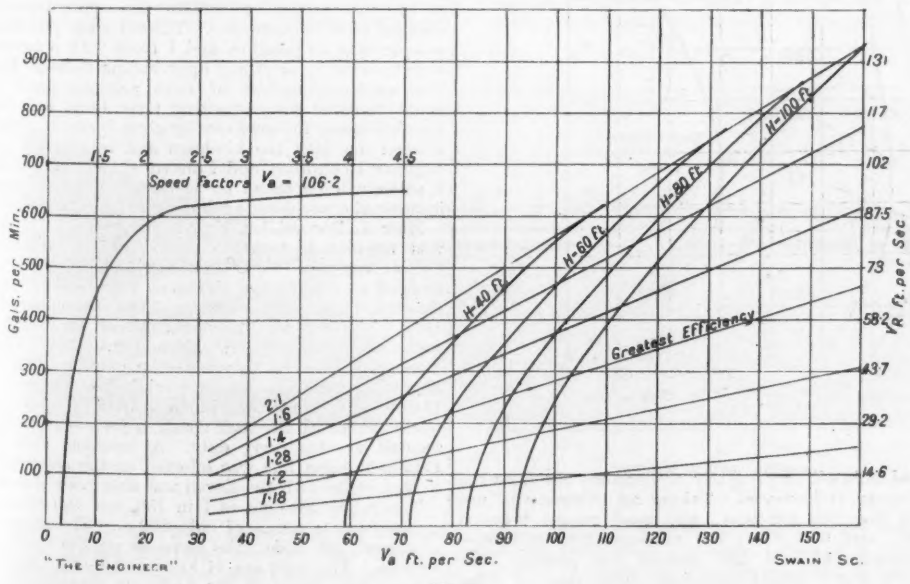



Fig. 26

The curvature of the impeller blades and the shape and proportions of the conversion passages also influence speed factors.

The permutations of pump design are too numerous for the establishment of a formula to apply in every case. It will be seen that $f$ in the present divergent examples of design covers a range from 0.85 (probably the lowest attainable) to 2.1.

The application of these diagrams is simple. The speed for a given pump, quantity and head being $f\sqrt{2gH}$.

*Relation between Quantity and Impeller Diameter.*—The importance of proportioning the diameter of an impeller from the diameter of the eye, or eyes in a double suction impeller, has been pointed out. It must be remembered that the suction pressure is due to an elastic atmosphere, and that high suction velocities should be avoided, especially in pumps to work at high altitudes. In Fig. 23 the stationary entry to the eye is proportioned like a convergent nozzle to avoid loss of suction head. But acceleration of flow in a passage having obstructions is liable to produce cavitation, and it would seem better to lead the water in at a uniform low velocity.

The quantity delivered in gallons per second for a given impeller loss, with a given speed factor, may be approximated in this manner. The theoretical velocity to obtain the head $H = \frac{(2\pi N R)^2}{2g}$. The foot-pounds per second due to $10\,Q\,H = 10\,Q\,\frac{(2\pi N R)^2}{2g} = 6.13\,Q\,N^2\,R^2$. The impeller losses in foot-pounds $= 0.123\,N^4\,f^4\,R^5$. Assuming impeller losses as 1 per cent. of the useful work 10 Q H, then $0.123\,N^4\,f^4\,R^5 \times 100 = 6.13\,Q\,N^2\,R^2$, and $Q = 2\,N^2\,R^3\,f^4$. In the pumps illustrated the impeller losses range from 15 per cent. to 32 per cent. of the useful work.

The relationship between N and R can be obtained approximately from the empirical formulæ:—For heads up to 40ft. $R = 0.23\sqrt[3]{Q}$; for heads between 40ft. and 80ft. $R = 0.25\sqrt[3]{Q}$; for heads between 80ft. and 100ft. $R = 0.27\sqrt[3]{Q}$.

*Conversion of Velocity into Pressure.*—Unrestrained particles of water from the periphery of a rotating impeller leave in a tangential direction at a tangential velocity. As the quantity is increased the direction and velocity are modified by the direction and velocity of the radial flow. The proportions of conical nozzles are known in which velocity is converted into pressure with the least loss of head, and it is generally accepted that a conical pipe whose walls have an inclination of $2\frac{1}{2}$ deg. to the axis is efficient in this respect. If it were possible to surround the periphery with a number of such conical pipes, arranged so that their axes were in the direction of a particle of water leaving the impeller, and of such an area at the throat as to suit the quantity and velocity of the water delivered, it would seem as though the highest efficiency of conversion would be reached. But practical considerations make such an arrangement difficult.

The pumps shown in Figs. 2 and 10 have conversion chambers without partitions or guide blades. The pump—Fig. 2—was arranged so that the distance between the walls of the conversion chamber could be easily altered. A number of experiments was made, but the results were only sufficient to indicate that the diameter of the chamber was insufficient for proper conversion, and that if units of conversion chamber could be made to approximate in areas and direction

* No. I. appeared June 12th.

to those of the suggested conical pipes, efficient conversion would take place. This was tried in the pump—Fig. 10—with the results already recorded. It will be seen that the entrance to the conversion chamber is proportioned like that of an efficient convergent nozzle, and if sections were taken in the direction of motion of a free particle, they would be found to correspond with those of an efficient convergent and divergent nozzle. The periphery is, in fact, surrounded by an annular convergent and divergent nozzle, whose areas correspond to those of efficient conical convergent and divergent nozzles on the lines of a Venturi tube. The path of a particle of water through the annulus at the most efficient output represents the length of the nozzle. If suitable transverse partitions are added, then we have a number of convergent and divergent nozzles of rectangular cross-section. In the pump—Fig. 10—it will be seen that the divergent portion of the conversion chamber is surrounded by a stilling chamber, the idea being that the water should enter the volute without eddy. It is doubtful whether this stilling chamber is of any advantage. With a low radial velocity the conversion chamber is merely a vortex chamber, and the water is whirled round within it, but as the radial velocity is increased the path of a particle approaches a straight line.

The length of the divergent part of the annulus or nozzles should be such that with a mean angle of divergence of 2½ deg. to the axis, the area of the outlets should give a velocity of flow equal to that in the volute, or delivery chamber. The conversion passages of the pump—Fig. 21—were developed on these principles. The partitions are of substantial form to resist mechanical injury or erosion, but they have a fine entry and run like those of a fast ship.

As the resultant of $V_a$ and $V_R$ decreases, so will the length of the conversion passages become less, until a point is reached when conversion passages are of no value and had better be omitted. It is thought that for pumps up to 40ft. head, with low radial velocities, conversion passages do not add to efficiency.

*Compensating or Self-regulating Pumps.*—It is sometimes convenient to install a pump which will work with a good average efficiency at a constant speed through a considerable range of head. In such a case a pump having characteristics illustrated in Fig. 11 is of advantage. It will be seen that the head falls off very rapidly at constant speed as the quantity is increased. Taking an efficiency of not less than 60 per cent., the head ranges between 90ft. and 60ft., and the corresponding quantities between 180 and 360 gallons per minute. The power curve differs materially from that of other diagrams. Instead of rising rapidly as a "short circuit" is approached, it falls off. In this instance the power ranges between 8.5 and 10.9 brake horsepower for the heads given.

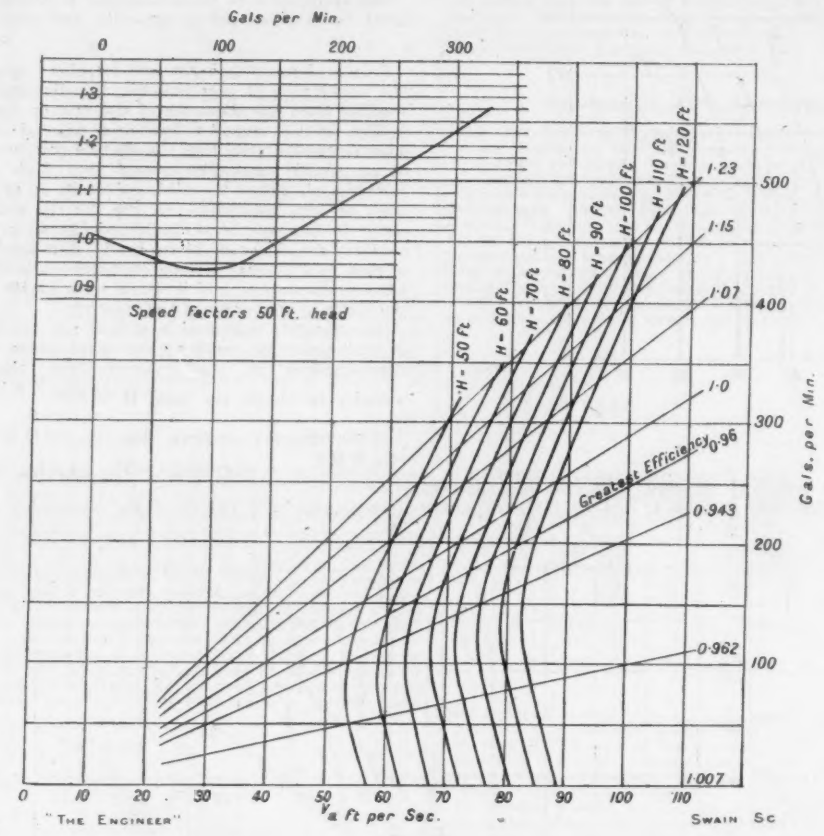



Fig. 28

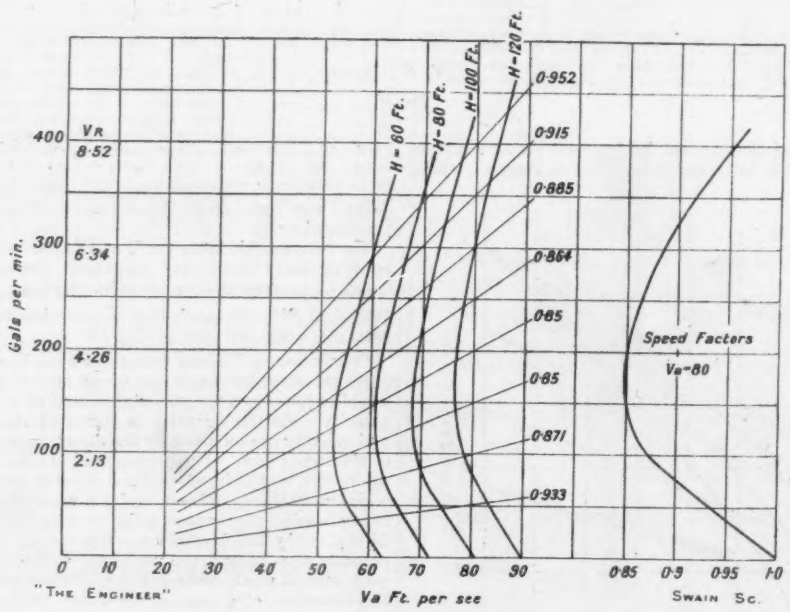



Fig. 29

The relation between H and $\frac{V_R^2}{2g}$ is of interest. It will be seen that $\frac{V_R^2}{2g}$ increases in proportion to the decrease of H. This formulated gives

$$H = \frac{(V_a - V_R)^2}{2g},$$

but as a short circuit is approached, atmospheric pressure (Francis's paradox) increases $V_R$ somewhat, and if the whole atmospheric pressure were available $V_R$ would become $\sqrt{2g \times \left(\frac{V_a}{2g} + 34\right)}$, when H = O, and assuming $f = 1$. The head due to $\frac{V_R^2}{2g}$ is partly expended in producing velocity of flow through the pump and pipes, and is partly lost owing to the backward curvature of the impeller blades. A careful comparison between Figs. 6 and 11 is suggested. If $\frac{V_R^2}{2g}$ were lost, as in Fig. 6, the power curve would rise, and there would be no compensation. It should be noted that $V_R$ is gradually increased from the eyes to the periphery of the impeller, and the $V_R$ given in the diagram is that at the periphery.

Experimental impellers with backwardly curved blades produced little compensating effect when worked in the pump—Fig. 2. From this it may be surmised that the improved proportions of the conversion chamber—Fig. 10—were partly responsible for compensation.

The disadvantage of pumps having rapidly descending characteristics is that they are large for their efficient output; or, in other words, their speed factors are high.

*Centrifugal Pumps as Air Pumps.*—During a number of experiments gauges were connected to various parts of the pumps under test. It was found that the pressures in the impeller chambers varied considerably. This appeared to be due to these causes:—Head produced by the friction of rotation; induction caused by radial flow; and a combination of both. In the pumps—Figs. 2 and 10—the pressure in the impeller chamber near the eye was always one atmosphere less than the pressure in the delivery chamber. When the pumps were short-circuited, and there was no head except that due to pipe friction, the pressure in the impeller chambers closely approached zero. The best vacuum was obtained with the pump—Fig. 10. Air was admitted through a cock and pipe joining both sides of the impeller chamber without materially decreasing the vacuum. The experiments, however, were intended for the purpose of arriving at efficient pump proportions, and the apparatus at the disposal of the author was insufficient for the accurate measurement of the quantity and pressure of air.

## RAILWAYS IN CHINA.

*(By our Special Commissioner.)*

No. V*.

TIENTSIN-PUKOW RAILWAY—NORTHERN SECTION.

DETAILS regarding the raising of the capital and the percentages apportioned by the Anglo-German Loan Syndicate to the Northern and Southern Sections of this line will be found in the preamble of the article on the Southern Section.

This section being built by German engineers and the Southern Section by British engineers, and there having recently been considerable controversy in the local Press regarding the workmanship and cost of the two sections, it will be impossible to avoid making some comparisons. These I shall put down as sparingly as possible, and I trust with a fairness uninfluenced by anything approaching national bias. The engineers-in-chief of both sections gave me equal facilities for inspecting their lines, and any figures I asked for were readily given by both. Each treated me with the kindness and courtesy of one engineer to another, and I am sure that any remarks I make will be taken by them as in the common interest of a world-wide profession.

Herr J. Dorpmüller, Kgl. Pr. Baurat. (Germany), was appointed engineer-in-chief of the Northern Section early in 1908. Construction work was commenced on July 1st of the same year, and the first through train service began about December 1st, 1912. The line was, however, opened for traffic in various sections from November, 1910. From Tientsin Central to Tsinanfu—the junction with the Shantung Railway—was opened before the end of 1910. As the Shantung line was then doing a good trade as far as the east coast, a lot of traffic was secured at this early date. A junction with the Peking-Mukden line was effected at the same time, so that trade with the North was also made possible.

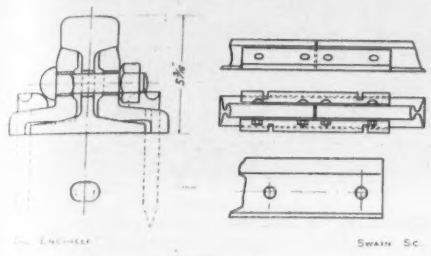
The ruling gradient is 1 in 150, and the sharpest curves have a radius of only 200 m. The gauge is, of course, 4ft 8½in., the same as on the Southern Section. The rails are 41 kilos. per metre—slightly lighter than those of the Southern Section. They are also of a different section, that of the Imperial Railways of Germany being adopted. The sleepers

* No. IV. appeared June 5th.

are of Japanese oak, half the quantity being creosoted. They measure 8ft. by 6in. by 9in. The rail is not dogged to the sleeper, as in the Southern Section, but rests on a plate about ½in. thick, through which holes are punched to receive the screw spikes which hold the rail in position.

The rail joints are facing, whereas those on the Southern Section are staggered. Whatever may be the ultimate verdict on the merits of staggering, it certainly makes for smooth running at present, and the effect is noticeably in its favour when the train passes from one section to the other.

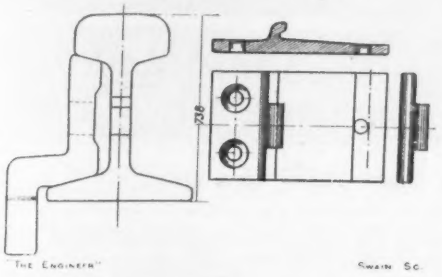
The ballast is mostly of limestone, granite and clinker brick, but there are places where sand and




ENGLISH RAIL

smooth river bed stones are used. The ballasting is light and uneven.

The stations are built of red brick, and have prettily curved tile roofs over neatly angled gables. The style is Oriental, and in particular Chinese. The effect would be artistic, but for the fact that the station houses stand on vast level plains, bare and treeless. Those who crowd about them, too, come far short of the ideal frequenters of beautiful buildings. These things will doubtless change with years, but so will the buildings, and by the time Nature and civilisation have done their part, the buildings will have fallen into decay, and probably ruin. Meanwhile these station houses are something to live up to. In Germany or England they would have been sur-

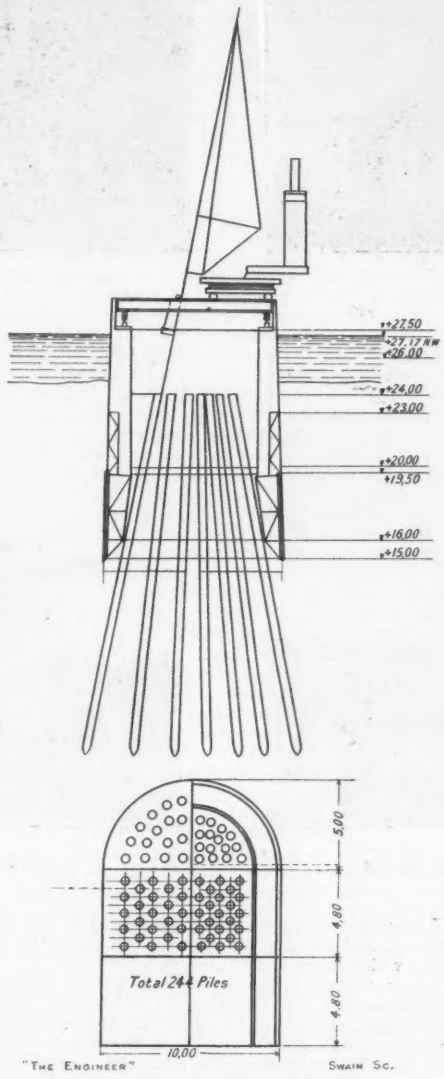



GERMAN RAIL

rounded by flowers and shrubs before now. But China is deficient of a sense in this respect. The people have lost the idea of the fitness of things, and cannot understand maintenance where art or skill are concerned. Life in China means a struggle to get food for the living and room for the dead. And each generation, notwithstanding the inevitable famine and pestilence its own congestion breeds, contrives to make the next generation worse by multiplying its numbers while making no provision for its needs.

I have said that the line is in some places ballasted with broken clinker brick. There was difficulty about getting stone, for a long stretch of the Northern Section runs through a vast plain where there is only alluvial and loess. When it was proposed to quarry in the distant hills the transport was either too expensive or the rights of quarrying were held up for the purposes of "squeeze." Mr. Dorpmüller was not to be beaten by any of these difficulties, and so he built numbers of kilns all along the route. In these he burnt the loess and alluvial matter to a clinker and then broke the product up into ballast.

It was found that only the lower bricks in the kiln could be clinkered, but that the upper ones were of sufficient hardness to be of use for building purposes. It was resolved to use these for station houses and platforms. But there were more than enough being produced, and in order to utilise further the heat from clinkering, tiles were made and put on the top of the kilns. These turned out to be of good hard quality. They were moulded into artistic shapes, and now form the prettily curving roofs on the line side. The cost has been carefully worked out, and is put down at less than half that of ordinary bricks and corrugated




PILING YELLOW RIVER BRIDGE PIERS

iron. Thus it came about that these Oriental buildings are really a by-product.

As to the clinker ballast. I examined this carefully, and after three years' exposure it is as good, if not better, than any stone to be found within a hundred miles of the line. The question of ballast-getting in China is a big one. If there is a rock hill in the vicinity, either some sentimental objection is raised against blasting on it, or the "rights" are cornered and the price made excessive. Here is a case for inquiry. If clinker brick can be produced at less than the average cost of stone, it should be adopted as the standard ballast of China. The Board of Communications should take the question in hand, and have it placed once for all beyond a doubt. The question of durability could be dealt with at the same time.

The Yellow River Bridge is the largest stone pier bridge in China. It is 1244.4 m. long. The central span is 164.7 m. long, and is built on the cantilever principle. On either side of this is an anchor arm span, 128.1 m. There are nine truss spans of 91.5 m. each. The bridge is an imposing structure, and can be seen rising from the plain long before it is reached. No solid rock foundations could be found, and reinforced piles were driven at angles to give a spreading base. The manner in which the caissons were sunk and the structure of the piers are shown in the accompanying drawings and photographs.

The superstructure is wide enough for a double track, and only the sides need strengthening when doubling is decided on. The weight of steel used in the construction is given as 11,000 tons, and the cost at 4,564,358 kooping taels, or roughly £560,000.

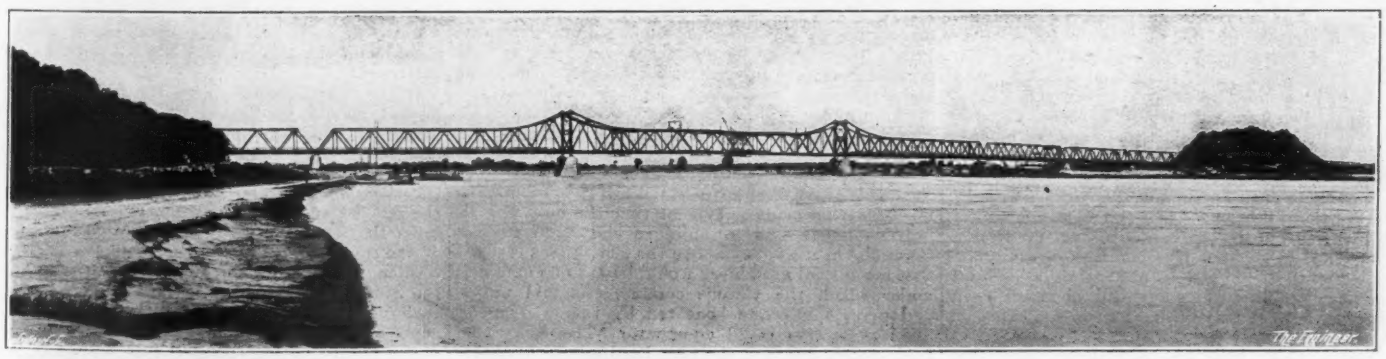
Other bridges over 500ft. long are:—The Tsauhwang Ho,* 235 m.; Tsihai Ho, 180 m.; Sha Ho (1), 280 m.; Sha Ho (2), 200 m.; Pan Ho, 230 m.; Tawonn Ho, 360 m.; Hsiauwonn Ho, 170 m.; Tse Ho, 270 m.; Peisha Ho, 240 m.

The cost of all bridges and openings, excluding the Yellow River bridge, was 7,539,885 kooping taels, or roughly £900,000. With the Yellow River bridge, which for some reason is always given separately, the total is close on one and a-half million pounds sterling. For the benefit of anyone who cares to go into the figures minutely, the kooping tael is taken in the accounts at a value varying from 2s. 6 1/16d. to 2s. 8¾d. There are no tunnels; indeed, there is not a tunnel from Pukow to Tientsin.

The locomotives and all the rolling stock imported from abroad were, without exception, built in Germany. The carriages are all fitted with the Westinghouse brake and the Janney type of coupling has been adopted. In these two particulars they correspond to the practice of the Southern Section, and of the lines to the North, but in almost every other particular they are different. Even the system of carriage heating is different, so that it would be impossible to take through passengers with any degree of comfort in cold weather.

This is, in short, an entirely distinct line coming in between lines which more or less conform in general features. The official language of all the Chinese Government lines is Chinese, but each engineer-in-chief seems to have considered it his duty to his native country to introduce that country's practices and language. The time-tables for foreigners and the alternative names on all stations are in English on British-built lines, German on German-built lines, and French on French-built lines. The official designation of the Southern Section is "Tientsin–Pukow Railway, Southern Section." That of the Northern Section is "Kaiserlich Tientsin-Pukow Eisenbahn Nordstrecks," and yet they are only divided by an imaginary line. All the stock is marked accordingly. It is quite natural and right that the builder should stamp his work with his own national characteristics, but in the matter of language some consideration should be given to the fact that English has been adopted as the business language of China. I have spoken to many foreigners on this subject, and they all agree that where the Chinese language must have an alternative that alternative should be English.

I must now deal with the vexed question of cost of construction. If I were to give all the figures submitted to me on this subject they would fill up a whole issue of THE ENGINEER. I give below the cost per mile for both sections worked out on the basis of all money supplied from every source less the amount expended on the service of the loan. The difference, according to these figures, is £2004 per mile in favour of the Southern Section.




YELLOW RIVER BRIDGE

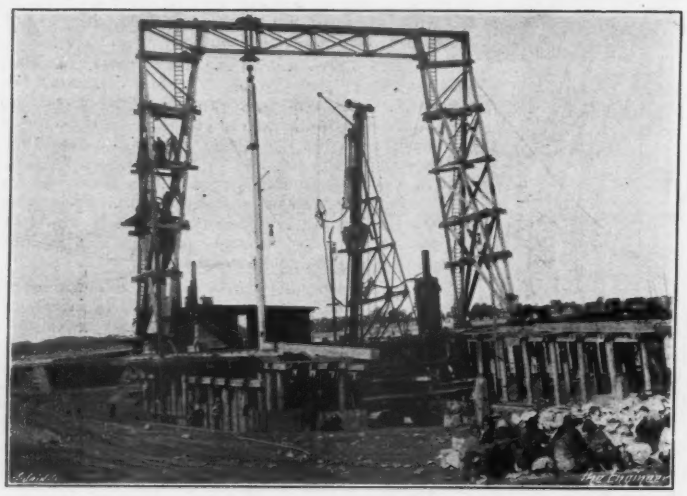
The real cost of a railway is what it stands at in the books of the owners. To the Chinese Government this means the face value of all money raised, so that both these lists must be increased by the amount of the loan services. At the same time it should be remembered that neither of the engineers actually handled the full amount attributed to them. There is the cost of land, for instance, and various purchases,

* Ho means river.

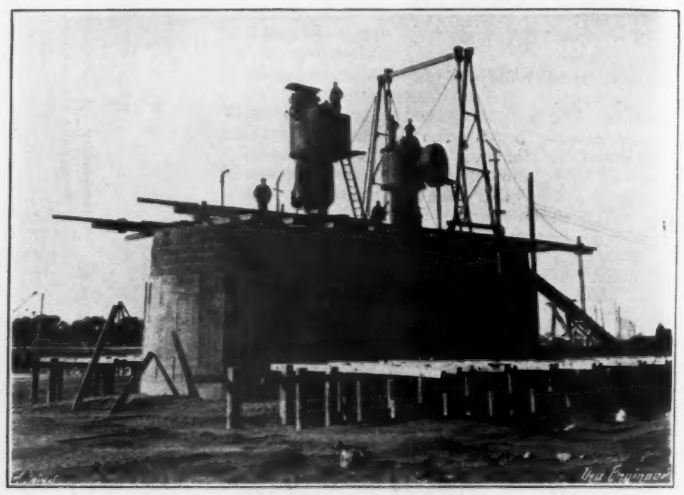
# TIENTSIN-PUKOW RAILWAY, CHINA—NORTHERN SECTION

TYPICAL STATION

WORKSHOPS IN TSINAFU



DRIVING PILES IN PIERS OF YELLOW RIVER BRIDGE



SINKING A CAISSON, YELLOW RIVER BRIDGE

expenses, and commissions entirely apart from railway construction.

*Northern Section.*

| | |
|---|---|
| Amount derived from issue of bonds .. .. .. | £4,743,900 |
| Amount borrowed from Southern Section .. .. | 250,000 |
| Amount borrowed from Deutsch Bank .. .. .. | 642,081 |
| Sundry creditors' and debtors' balance (say) .. .. | 140,600 |
| Total .. .. .. .. | £5,776,581 |

Total length of main line and branches, 455 miles.
£5,776,581 ÷ 455 = £12,696 per mile.

*Southern Section.*

| | |
|---|---|
| Amount derived from issue of bonds .. .. .. | £2,712,100 |
| Amount advanced by Loan Syndicate .. .. .. | 172,000 |
| | £2,885,100 |
| Less loan to Northern Section (£250,000) : loan cash in bank (£106,278) .. .. .. .. .. .. | 356,278 |
| Total .. .. .. .. | £2,528,822 |

Length of line, 236¼ miles.
£2,528,822 ÷ 236¼ = £10,692 per mile.

While I have put down the above figures, no one will suppose that the result obtained by dividing the amount in sterling by the number of miles is an indication of extravagance or economy. It is impossible to arrive at relative costs in this way, and I need not give items to show that every line must stand on its own basis with regard to costs. Besides, neither of the sections has ceased to require money, and neither of them is fully equipped. The Pukow terminus will not be completed for a considerable time, and there is also a good deal of work necessary on the Northern Section. Then one section is almost twice the length of the other, and this should make a big difference in the cost per mile if everything else were equal. It should also be noted that no account is taken of traffic earnings, which have all been absorbed by both sections, either for running expenses or construction purposes.

I cannot close this article without expressing surprise and regret that the engineers of both sections did not meet and decide on common action, especially with regard to matters which would effect through running before work was commenced. It seems to have been overlooked that, although the money for the respective sections was lent by different countries, the railways were being built by the Chinese Government for the benefit of China. In both agreements it is stipulated that on completion the two sections shall be run as one line, and under one management. It baffles me to understand how, in view of this, two engineers could commence work without a thorough understanding.

I have put down the main differences in the two sections, and those who read must decide for themselves which, in any particular, they prefer.

I do not blame either engineer-in-chief for ordering all he could from his own country. As a matter of fact, this benefit was one of the chief considerations with those who raised the money. It is, however, a noticeable feature that while on the Southern Section some locomotives were bought from America, nothing at all was bought for the Northern Section from any country but Germany.

## THE CONSERVANCY LAW OF OHIO.

By KENNETH C. GRANT, M. Am. Soc. C.E.

ON February 6th last, the Legislature of the State of Ohio passed an Act which is destined to show itself to be one of the wisest and most far-sighted laws that has ever been placed upon the statute books of any State in the Union. This Act, known as the Conservancy Law of Ohio, was finally made a law by the Governor's signature on February 17th. The purpose of the Act as set forth is "to prevent floods, to protect cities, villages, farms, and highways from inundation, and to authorise the organisation of drainage and conservation districts." The Act was drawn up under the direction of the Dayton Flood Prevention Committee, which has prepared plans for the protection of that city from the floods of the Miami River. When the preliminary investigations made it evident that the best way to prevent floods was to build several large storage reservoirs in the valley above the city, it was realised that some legal machinery would have to be obtained under which the various communities and public and private interests benefited by this widespread flood protection could co-operate. The committee immediately engaged the best legal advice available in the country, and after several months of the most careful study the Conservancy Law was drawn up just in time to be presented at a special session of the Legislature on January 19th last.

The Law provides that a petition for the formation of a Conservancy District may be filed in the Court of Common Pleas of any county lying wholly or partly within the proposed district. This petition must be signed by 500 freeholders, or by a majority of the freeholders, or by the owners of more than half the property in either acreage or value within the limits of the proposed district. The petition must set forth the necessity for the proposed work, and show that it will be conducive to the public health, safety, convenience, or welfare. It must also give a general description of the purpose of the contemplated improvement, and of the territory to be included in the proposed district. A district may be organised for all or any of the following purposes :—

(*a*) Of preventing floods.
(*b*) Of regulating stream channels.
(*c*) Of reclaiming wet and overflowed lands.
(*d*) Of providing for irrigation.
(*e*) Of regulating the flow of streams.
(*f*) Of diverting or eliminating watercourses.

At some time prior to the hearing on the petition the petitioners must file a bond sufficient to pay all expenses connected with the proceedings in case the court refuses to organise the district. Immediately after the filing of the petition, advertisement of it and of the time and place of the hearing on it is made for three weeks in the newspapers. At any time between the filing of the petition and the hearing any property owner within the proposed district who wishes to object to the organisation and incorporation of the scheme may file his objections with the court.

If the court decides, upon the hearing, that the district should be formed, it declares the district organised, and thereupon it becomes a political subdivision of the State of Ohio, with perpetual existence and with all the powers and rights of a public corporation. After an order is entered establishing the district such order is deemed final and binding upon the real property within the district. Copies of the findings and of the decree of the court establishing the district are filed with the Secretary of the State of Ohio and with the County Recorder of each county having lands in the district. If the court finds that the property set out in the petition ought not to be incorporated into a district it dismisses the proceedings and adjudges the costs against the signers of the petition. If the district lies in more than one county the hearing on the petition is held before a court consisting of one Common Pleas Judge from each county having land in the district.

After the decree incorporating the district is entered the court appoints three persons, at least two of whom must be resident freeholders within the district, to be a board of directors of the district. Their term of office is five years, and they receive 5 dols. per day for each day actually employed. The board of directors employs such engineers, attorneys, and other assistants as it deems necessary. The

board then prepares a plan for the improvement of the district, and upon its completion publishes notices that it may be inspected by all persons interested, who, if they so desire, may file with the board, in writing, objections to the plan. A public hearing is then held on the plan before the board of directors, after which the board adopts the plan as the official plan of the district. If, however, any person objects to the plan adopted he may file objections in writing with the court that established the district. This court then fixes a day for a hearing on these objections, after which hearing the court adopts or rejects the official plan or refers it back to the board of directors. If the court rejects the plan the directors prepare another plan. If the court refers back the plan to the directors for change the hearing is continued to another day. The board of directors has full power to construct and maintain the works contemplated in the official plan. It may carry out these works with its own workpeople, or it may let contracts. The board is given a dominant right of eminent domain over the right of eminent domain of other public and private corporations. The Act also gives the board control over the placing of all obstructions in or along the streams within the district and over the pollution of the waters thereof.

If the official plan requires the change or removal of any structure which obstructs flood flow the work of alteration or removal is at the expense of the owner, but such change or removal may not be required if, upon a hearing before the court, it can be shown that the cost thereof will be greater than the benefits resulting therefrom. When the carrying out of the official plan demands, the directors may require the temporary removal of a bridge or gradient in order to allow the passage of equipment, the expense of such removal being borne by the district. The Act gives the board of directors authority to co-operate with the United States Government with the Government of any State, with public or private corporations, with other districts, or with private parties in constructing and maintaining the works of the district.

The board of directors is required, at least once a year, and oftener if ordered, to make a report to the court of its proceedings and give an account of receipts and disbursements to date. These accounts are audited and a report thereon filed with the clerk of the court.

At the time of making its order organising the district, or at any suitable later time, the court appoints three appraisers, who must be recommended by the board of directors and approved by the court which conducted the hearing on the petition. The duty of the appraisers is to appraise all benefits and damages accruing to all lands within or without the district by reason of the execution of the official plan. These appraisers continue to hold office until excused by the court. They receive 10 dols. per day for each day actually employed.

During the preparation of the official plan the appraisers are required to acquaint themselves thoroughly with the plan and with the lands and other property affected by it. When the official plan is adopted the appraisers proceed to appraise the benefits and damages that will result from its execution. In this work they have the assistance of the engineers, attorneys, and others employed by the board of directors. If the appraisers find that property not included in the district will be affected by the proposed improvement they appraise the benefits or damages to such property and file a notice in the court of such appraisal. They also report to the court any lands which they consider should be eliminated from the district. In the former case the clerk of the court gives notice by publication to the owners of the property that their lands are to be added to the district and that a hearing will be had on the matter at a certain time and place, which may be the time and place of the hearing on appraisals. In the latter case it is sufficient to notify the owners that their property is excluded from the district.

When the report of the appraisers is completed it is deposited with the clerk of the court having the original case. Copies of that part of the report giving the appraisals of benefits and damages in each county are made and filed with the clerk of the Court of Common Pleas of that county. The clerk of the court then advertises that the report of the appraisers is filed and that there will be a hearing on it at a given time and place. Any property owner may, within ten days after the last advertisement, file exceptions to the whole or any part of the report of the appraisers. At the hearing on the appraisals the court may order the appraisers to amend their report or it may refer the report back as a whole to the appraisers. In the latter case a new notice for a hearing is required. If the court finds that the cost of constructing the improvement contemplated in the official plan is less than the benefits appraised it approves the report of the appraisers. In case the court finds that the estimated benefits appraised are less than the total cost of the execution of the official plan, or that the official plan is not suited to the requirements of the district, it may, at its discretion, return the plan to the directors with the order for them to prepare new or revised plans, or it may disorganise the district.

Any person or corporation desiring to appeal from an award as to compensation or damages or benefits must, within ten days from the judgment of the court confirming the report of the appraisers, file with the clerk of the court a written notice making demand for a jury trial, and stating definitely from what part of the order appeal is made. The case is heard before a jury in the county in which the property in question is situated.

The monies of a conservancy district consist of three separate funds:—(1) Preliminary fund, which consists of the proceeds of the *ad valorem* tax authorised by the Act and such advances as are made from the general county funds as provided for in the Act; (2) bond fund, which consists of the proceeds of levies made against the special assessment of benefits provided for in the Act; (3) maintenance fund, which is a special assessment levied annually.

The preliminary expenses of the proceeding are met as follows:—After the filing of the petition, and before the district is organised, the costs of publication and other official costs are paid out of the general funds of the county in which the petition is pending. If the district is organised these costs are repaid to the county out of the first funds received by the district through levying of taxes, selling of bonds, or borrowing of money. If the district is not organised then the costs are collected from the petitioners or their bondsmen. As soon as a district is organised the board of directors has power to levy upon the property of the district a tax not to exceed three-tenths of a mill upon its assessed valuation as a level rate to be used for paying all necessary expenses up to the time money is received from the sale of bonds or otherwise. This tax is certified to the auditors of the various counties within the district and collected in the same manner as other county taxes. The board of directors may borrow money by pledging the receipts from such taxes for its repayment. After the list of real property, with the appraised benefits as approved by the court, has been filed with the secretary of the district, then the board of directors levies on all real property upon which benefits have been appraised an assessment of such portion of the benefits as it finds necessary to pay the cost of the execution of the official plan, which assessment, however, may not exceed the appraised benefits. This assessment is apportioned to and levied on each tract of land or other property in proportion to the benefits appraised and not in excess of them. If it should be found at any time that the total amount of assessments levied is insufficient to pay the cost of the execution of the official plan the directors may make an additional levy to provide funds to complete the work, provided that the total of all levies does not exceed the total of benefits appraised.

Any property owner assessed as above for the execution of the official plan has the privilege of paying his assessment in full, without interest, within thirty days from the time such assessment is placed on file in the office of the district. Any property owner failing to pay his assessment in full as above is deemed to have consented to the issue of bonds, as described hereafter, and to payment of interest thereon. After the expiration of this period of thirty days the board of directors apportions the uncollected assessments into instalments or levies, provides for the collection of interest upon the unpaid instalments, and orders the issue of bonds in an amount not exceeding 90 per cent. of the levy, in anticipation of the collection of the instalments. These bonds must be executed and delivered to the treasurer of the district, who must sell them in such quantities and at such dates as the directors may deem necessary to meet the payments for the work of the district. A sufficient amount of the assessment must be appropriated by the directors for the purpose of paying the principal and interest of these bonds, and this amount, when collected, must be set apart in a separate fund for that purpose and no other.

After the works contemplated in the official plan are completed the board of directors, on or before September 1st of each year, levies an assessment upon all property within the district subject to assessment under the Act. This assessment, known as the "Conservancy Maintenance Assessment," is apportioned upon the basis of the total appraisal of benefits, and may not exceed 1 per cent. thereof in any one year unless the court shall authorise an assessment of larger percentage. Upon the petition of the owners of 25 per cent. or more of the acreage or value of the lands within the district a new appraisal of benefits may be made for the purpose of making a more equitable basis for the levy of the maintenance assessment; but this readjustment of benefits may not be made oftener than once in eight years. The same proceedings follow as in the case of the original appraisal of benefits, already described.

Each year after the completion of the works the board of directors determines and levies the part of the total assessments levied under the Act, which becomes due and is collected during each year at the same time as the State and county taxes. This annual levy is certified by the board not later than September 1st each year to the auditor of each county having land in the district. The auditor, in turn, certifies it to the treasurer of the county, whose duty it is to collect it according to law. The county treasurer reports the amount he collects to the county auditor, who issues his warrant for the amount payable to the treasurer of the district.

All conservancy assessments and taxes provided for in the Act, together with all penalties for default in payment of, and all costs in collecting them, constitute, until paid, a lien upon all the lands and other property against which such taxes are levied. The Act also specifies the procedure in case the land lies within two districts, and in case the union of two or more existing districts is desired. It also provides for the organisation of sub-districts when the improvements contemplated affect only a part of the district.

The section of the Act relating to water power and supply is of such special interest to engineers and attorneys dealing with problems of water rights and to those who advocate the real conservation of water, that some verbatim quotations from it are given.

"The rights of landowners, municipalities, corporations, and other users of water to the waters of the district for domestic use, water supply, industrial purposes, for water power, or for any other purposes shall extend only to such rights as were owned by them prior to the organisation of the district, and to such use as could be made of such waters if the improvements of the district had not been made. Wherever the organisation of, or the improvements made by the district make possible a greater, better, or more convenient use of, or benefit from, the waters of the district for any purpose, the right of such greater, better, or more convenient use of, or benefit from, such waters shall be the property of the district; and such rights may be leased, sold, or assigned by the district in return for reasonable compensation.

"Where the district is a riparian owner along the streams of the district, it shall have, in addition, the rights which go with riparian ownership.

"All the rights and property of the district in the waters and watercourses of the district, and in their uses, shall be exercised in such a manner as to promote the welfare of the district, and of all inhabitants thereof, and to promote the safest and most economical and reasonable use of the waters thereof; to encourage and promote industries and agriculture, and to pay the cost of the construction and maintenance of the improvement. Charges for such use shall not be greater than are necessary to accomplish these purposes.

"Persons, corporations, municipalities, or other parties desiring to secure such use of the waters or watercourses of the district, or of the district rights therein, may make application to the board of directors for lease, purchase, or permission for such use. Such application shall state the purpose and character of such use, the period and degree of continuity of such use, the amount of water desired, and the place of use. In case any party makes greater, better, or more convenient use of the waters of the district without formal application, the fact of such use shall serve all purposes of an application, and the board may proceed to determine a reasonable rate of compensation the same as though formal application had been made."

. . . .

"The board of directors shall not permanently sell, lease, assign, permit, or otherwise part with the control by the district of the use of the waters thereof, and rates for light, power, or other services charged by vendees, assignees, lessees, or licensees of such board of directors shall be subject at all times to revision and control by State law.

"The board of directors may make regulations for the determination and measurement of the increased, or better, or more convenient use of, or benefit from, the water supply of the district, for the purpose of determining rates of compensation, and for the purpose of securing to all parties interested the greatest and best use of the water thereof.

"The compensation for greater, better, or more convenient use of, or benefit from the waters of the district may be made by payment according to a unit price per cubic foot of water used, or by a unit price for theoretical horse-power developed, or in any other reasonable measurement of value received by reason of the greater, better, or more convenient use of, or benefit from, the waters of the district. All money received as compensation under the provisions of this paragraph shall be added to the funds of the district and used for defraying the expenses thereof."

The first petition under this Act was filed by the Dayton Flood Prevention Committee on February 18th, the day following the signing of the Act by the Governor. This petition was filed with the County Clerk of Montgomery County, at the Court House in Dayton. It prayed for the formation of the Miami Conservancy District, which will include lands in ten counties of the State of Ohio. The main feature of the plans for the Miami Conservancy District is the construction of six large storage reservoirs with earthen dams. The five of these reservoirs situated above Dayton will have a total capacity of about forty thousand million cubic feet, and the largest reservoir a capacity of eighteen thousand million cubic feet. Large concrete tunnels sufficient to carry the normal flow will be built through the dams in the stream bed. These tunnels will have no gates, but will always be open, so that the only time the reservoirs will store any water will be during floods, when the discharge exceeds the amount it has been decided to allow to pass down the channels below the dams. All flow in excess of this amount will be temporarily stored in the reservoirs and gradually released as the flood subsides. In this manner the maximum flood discharge at Dayton, which, in the disastrous flood of March, 1913, reached about 250,000 second-feet from a drainage area of about 2500 square miles, will be reduced to about one-fifth this amount. The total cost of the work will be from 12,000,000 dols. to 15,000,000 dols., which is considered reasonable, in view of the fact that in the great flood of March, 1913, over 100,000,000 dols. damage was done in the city of Dayton alone, while several hundred lives were lost in the Miami Valley. It is expected that construction will be commenced this summer and completed within three years.

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THE trials of multiple-unit trains on the Silesian mountain railways have proved very satisfactory, and the service is to be extended to Fellshammer, and shortly to the Austrian frontier, at Halbstadt, a total distance of 35 kiloms. The full electrical service will be put into operation before the end of the year, and the working of through trains by locomotives will commence during this summer. To the existing motor generator station at Nieder-Salzbrunn will be added others at Ruhbank, Hirschberg and Lauban. The power station is in Mittelsteine.

## SINGLE-PHASE RAILWAY IN THE EASTERN PYRENEES.

No. II.*

WE described in the last article, which appeared last week, everything associated with this new electric railway with the exception of the rolling stock. There are four motor coaches with first and second-class passenger compartments, a luggage compartment, and drivers' cabs at each end. In the first-class section seating accommodation is provided for seven passengers, in the second-class compartment there is room for seventeen passengers, and there are four seats in each of the drivers' compartments. A drawing, showing in elevation and plan one of the motor coaches, is given in Fig. 11, from which the arrangement of seats, &c., will be readily understood. The total length of these motor coaches measured over the buffers is 11·66 metres. Access to the passenger compartments is gained through doors fitted to the drivers' compartments at each end. There are two motor bogies, the distance between the pivots of which is 5.18 m. Owing to the many sharp curves which these motor coaches have to negotiate special attention had to be paid to the design of the bogies. The axles have a fair amount of play, and, as can be seen from the drawing, there are centring springs. Moreover, to reduce the wear on the flanges of the wheels automatic lubrication has been fitted, which supplies to the flanges a small quantity of oil. All the coaches are fitted with Westinghouse automatic brakes, the air compressor for which—see Fig. 11—is driven by an 110-volt motor. The buffers are of the central type, with two springs enclosed in bushes and not back into the line, as on certain other single-phase railways. For supplying air to the motors in order that they may deal with heavy loads a ventilating fan is provided, which is operated by a 6 horse-power motor supplied with current at 45 volts. High-tension current collected from the overhead wire is supplied to two 96-kilovolt-ampère auto-transformers, which reduce the pressure to 350 volts. Connected to the windings of these transformers are five tappings giving pressures ranging from 100 to 350 volts. There is also a 45-volt tapping for the lighting and ventilating circuits. For braking purposes the motors are connected to the fourth and fifth tapping, as shown on the right of Fig. 12.

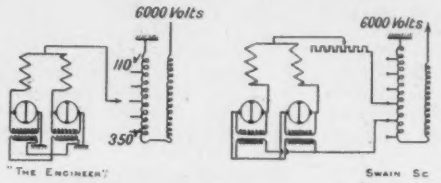


Fig. 12—BRAKING AND RUNNING CONNECTIONS

The controllers are of the tramway type, and have five running positions or notches corresponding to the five tappings on the auto-transformers and seven braking positions. There are three cylinders—one for setting the direction of running, one for braking, and one for speed control. The last-named cylinder is composed of two distinct parts, one dealing with the current of one transformer and the other part the current from the other transformer. It will be gathered, therefore, that the complete electrical equipment is divided into two sections, each composed of one transformer and two motors, and in the event of anything happening to one of the motors it can be isolated from the others.

The resistances used for braking purposes are cast iron grids, and are fixed on top of the motor coaches. They are enclosed in metal cases with openings in the sides, and the air which passes through them prevents undue heating. There are twenty of these resistance units per motor coach, each unit consisting of about 30 grids. Two resistance units of the same type are used in conjunction with the controller to prevent the circuit being broken when the main connections to the motors are being changed. The current collectors—see Fig. 18—are fitted with two contact pieces, which are held in contact with the overhead line by means of springs. The high-tension connections, which are quite ordinary, are shown in Fig. 13, from which it will be seen that the usual horn lightning arrester, choking coil, and resistance are connected to the collectors. It will further be noticed that there is a current transformer, which is connected to a release coil, and, in the event of excessive overloads, it releases the high-tension switch. It is also possible to open this switch by hand from the drivers' cabins. Two fuses are also interposed in the high-tension circuit, so that the transformers are well protected.

In the luggage compartment is a marble panel on which are mounted 110 and 45-volt switches for the lighting, heating, and other auxiliary circuits, such as the circuits for the compressor and fan motors. The transformers are oil-cooled transformers, and are enclosed in cases under the motor coaches in the manner shown in the drawing. In each driver's compartment there are, besides the main controllers, a press button for releasing the main oil switch, the brake cock, compressor switch, hand brake wheel, the control for the sanding gear, the handles for operating the current collectors, and the usual measuring instruments. The air compressor, as the drawing shows, is fixed in the luggage compartment, and the current collectors are fixed on top of this compartment.

Besides these motor coaches, the railway company has also purchased a number of trailer cars and goods wagons, all of which are fitted with Westinghouse automatic brakes. The whole of the equipment, we are told, has given entire satisfaction. Trials were carried out for twelve hours, during which period two trains made journeys simultaneously backwards and forwards on the up and down lines, and these tests indicated that the time-table could easily be conformed with, and that temperatures of the motors and transformers were well within the specified limits.

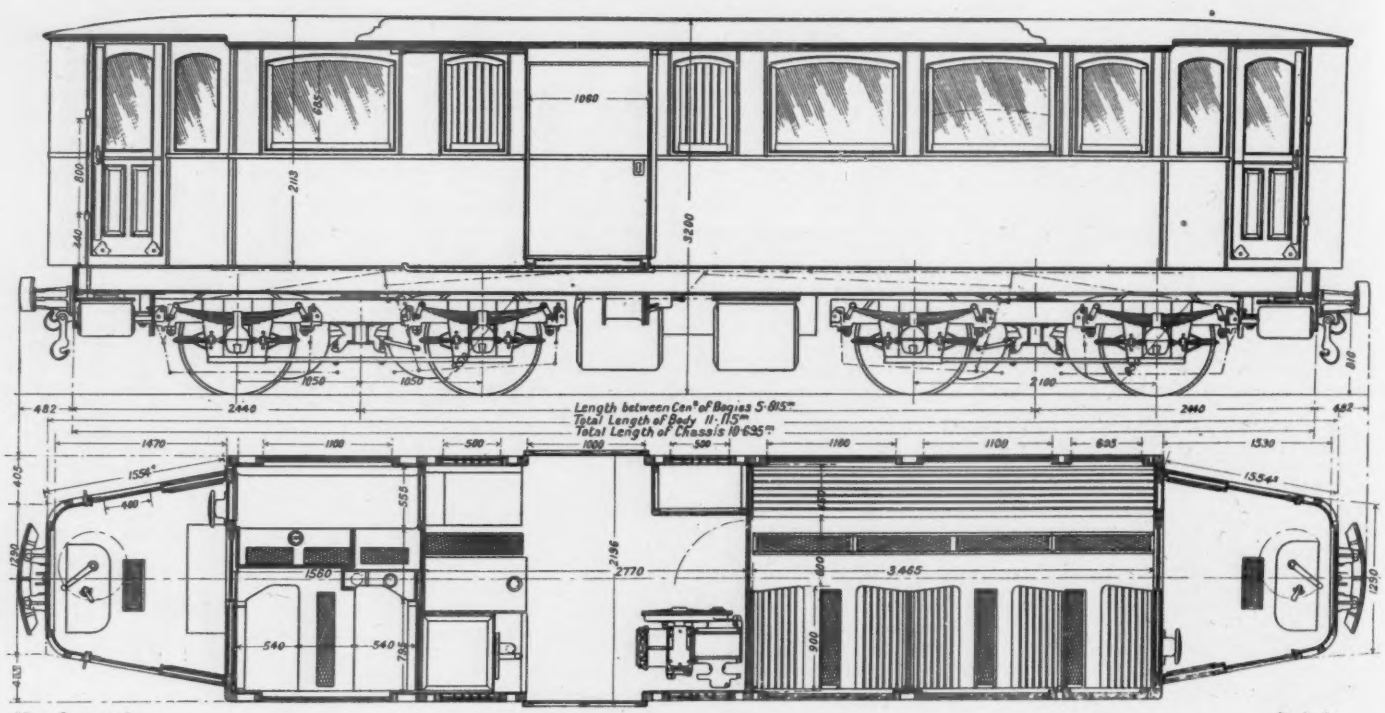


Fig. 11—SIDE ELEVATION AND PLAN OF MOTOR COACH

fixed to the chassis. Each bogie is fitted with two six-pole series repulsion motors of the La Tour type, so that there are four motors in all. Each motor is rated at 50 horse-power at 300 volts and 25 cycles per second. The casing is of cast steel, and is provided with two openings for ventilation. The following table gives the running characteristics :—

| Tractive effort on periphery of wheels. Kilos. | Revolutions per minute. | Efficiency. | Power factor. |
|---|---|---|---|
| 0 | 700 | — | — |
| 200 | 640 | .76 | .98 |
| 400 | 570 | .84 | .99 |
| 600 | 500 | .85 | .97 |
| 800 | 450 | .82 | .925 |
| 1000 | 400 | .79 | .88 |
| 1200 | 350 | .75 | .82 |

These figures correspond to a supply pressure of 300 volts. Power is transmitted from the motors to the driving wheels through gearing with a ratio of 1 : 4.72. The driving wheels are .95 m. in diameter. On a test on these motors in the workshop the temperatures were found after the usual period to be as follows :—Stator, 33 deg. Cent.; rotor, 40 deg. Cent.; and commutator, 55 deg.; the pressure being 300 volts and the current 162 ampères. It was specified that the temperature rise should not exceed 75 deg. Cent., so that the actual results were within the guarantee. The motors, as the drawings show, are spring supported, and are arranged for electrical braking. On the right of Fig. 13 the connections for electric braking are shown, and on the left the running connections. It will be perceived that when the motors are regenerating they send the current into resistances

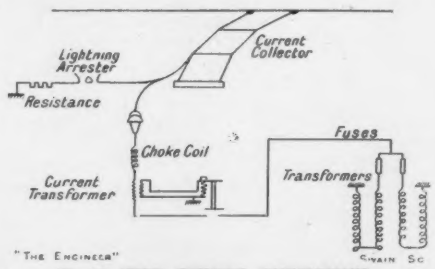


Fig. 13—HIGH TENSION CONNECTIONS

* No. I. appeared June 12th.

## THE ROYAL COMMISSION ON RAILWAYS.

No. XV.*

MR. JACKSON was the only member absent when the Royal Commission resumed its sittings after the Whitsun recess on Wednesday, the 10th inst., on which occasion Sir Charles J. Owens, the late general manager and now a director of the London and South-Western Railway, opened the evidence on behalf of the railway companies, dealing with matters in general, and specifically with questions affecting the London and South-Western. As the "proof" had only been in the possession of the members for a couple of days, it was agreed that Sir Charles should give his evidence in the form of a statement, but that his examination and cross-examination should stand over until the 24th inst. The following, then, are the main points of the statement, which, the Chairman remarked, was very far-reaching and the most important piece of evidence the Commission had been favoured with.

### METHOD OF QUOTING RATES.

Several witnesses had asked for station to station rates in all cases, in addition to collected and delivered rates, but this was the demand of the theorist and not of the trader. It meant four sets of rates :—(1) An s. to s. rate, (2) a c. and d. rate ; (3) a rate excluding the charge for delivery, (4) a rate excluding the charge for collection. There was trouble enough already to get the consignment notes correctly filled up, but if this plan were adopted it would give rise to endless errors and consequent disputes with

* No. XIV. appeared May 29th.

traders. It would also give opportunities to the staff to make mistakes. A c. and d. rate meant one inclusive charge; under other conditions there might be three charges. It was to the advantage of the trader, and only the theorist and doctrinaire objected. More than that, from 60 to 70 per cent. of the trade of the country was carried at special rates based on what was most acceptable to the trader. Answering Sir William Plender, the witness admitted that there might be c. and d. rates to stations where there was no delivery agent, but a rebate would then be given. The companies gave adequate returns for services not rendered. To Mr. Balfour he added that they did not voluntarily give the rebate in all cases, and it was hard to see how that could be done. Lord Derby raised the point as to the southern lines only quoting s. to s. rates, to which Sir Charles replied that to stations west of Salisbury the rates were c. and d., and he thought the whole London and South-Western system should be the same. He was goods manager when, in 1891, all the rates were revised, and he was then adopting c. and d. throughout. In the panic that ensued, when the public thought all rates were being raised, he feared the wisdom of changing the s. to s. rates for stations east of Salisbury to c. and d., so, as a question of policy, he retained the *status quo* on those sections. Asked as to the number of rates in force, the witness said that on the London and South-Western Railway there were 250 stations, and as each station exchanged with every other station, and as there were eight classes, the sum would be $250 \times 250 \times 8$, plus the special rates. If, then, separate quotations were to be given for the four varying services the number would be quadrupled. Sir Charles told the Chairman that 87 per cent. of the London and North-Western traffic was c. and d., and he feared that if it were intimated to the traders that they would have to pay three different charges where they paid one now, there would soon be trouble. It did not matter whether traffic was carted by the companies or their agents—that was a matter between the companies and agents, and the charges to the traders were the same in either event.

### Publication of Rates.

The witness had been surprised to hear that evidence had been given that rates had been charged which could not be found in the rate books. The obligation to publish was well recognised, and if there were omissions they were exceptional and capable of explanation. It was not only the duty but to the interest of the companies to publish their rates, as under Sec. 13 of the Act of 1888 damages, in the event of undue preference, cannot be awarded if the rate complained of has been duly published.

As to Mr. Marshall Stevens' suggestion—THE ENGINEER, March 13th—that the French rate book be imitated, Sir Charles said that this work was not so full as had been represented, and there were not so many special rates in France, where matters were regulated on cast iron rules.

### Alleged Undue Preference to Foreign Merchandise.

This charge, the witness said, implied alike a lack of patriotism and of business acumen on the part of railway managers. Every manager desired the prosperity of the district served by his railway, as on such prosperity must depend the ability of the inhabitants to use his railway. Further, he was restrained by law from giving foreign produce undue preference. The phrase "undue preference" caused confusion. Nothing was said in the Act of 1888 as to undue preference. What was made illegal—in Sec. 27—was difference of treatment, *i.e.*, differential rates, and they were only illegal when, in home or foreign merchandise, "in respect of the same or similar services" Differential rates were given when the conditions were different—generally speaking, when it became a wholesale instead of a retail transaction. The differences did not lie alone in quantity; packing formed a most important difference, also the regularity of traffic.

Special efforts had been made to secure co-operation and combination between home producers, so that they might get the lower differential rates for large quantities. These lower rates would not only benefit traders, but, getting the goods in larger quantities at one time, would reduce the expense to the company working the traffic. There was, however, mutual jealousy among the producers lest one should know the other's customers Sir Charles added that he was empowered by other companies to say that they, too, had attempted to obtain co-operation, but had also failed.

Witness quoted from the report of the Departmental Committee of 1904–5 as to alleged preferential treatment of foreign produce, in which it was said that "the evidence tendered failed to show that the railway companies were giving undue preferential treatment to foreign and Colonial produce as compared with home produce, contrary to the intention and effect of existing legislation." He also drew attention to the fact that the report also said, "The Committee would also suggest that the Board of Agriculture and Fisheries should issue circulars from time to time recommending producers to apply to the railway companies which carry their produce for the various rates at which the produce they may wish to send will be carried according to the method of packing and the size of the consignments." Sir Charles could not say if the Board of Agriculture had done anything in this matter.

### Glut Rates.

The evidence as to lower rates when there was a glut of fruit was mentioned in THE ENGINEER of March 27th. The witness said that the objection to a temporary lowering of rates in order to deal with exceptional circumstances affecting particular industries was the difficulty of raising them again afterwards. If temporarily lowered, and subsequently restored, the companies would, in the case of complaint, have to justify the reasonableness of the increase. This point was noted by the Departmental Committee of 1904–5, which recommended that the Act of 1894 be amended so as to allow for "glut rates." But even if these lower rates were permitted, Sir Charles was doubtful whether any good would come therefrom. Because, in the case of plums, the rates now in force for a distance of fifty miles to London, including delivery, worked out at ·083d. per lb. if in 1-ton lots, ·079d. per lb. in 2-ton lots, and ·074d. per lb. in 3-ton lots. This meant about 12 lb. for 1d., or 10 lb. if the package be included.

### Owners' Risk Rates.

The point of excessive difference, so often raised, between owners' risk and company's risk rates was the child of so-called railway experts, chambers of commerce and traders' associations; it was not one raised by practical business men.

In considering what was a reasonable difference, a very simple blunder was often made. It was not the value of the rate which was being insured, but the value of the goods, and as no common percentage could possibly be found which would be the measure of the premium for risk in each separate article in any of the various classes 1 to 5, a different rate for each of these articles, when sent at company's risk, would be created, and anomalies would arise which, in certain cases, might amount to undue preference or prejudice. Traders, generally speaking, were well satisfied with the liberal terms on which railway companies had made concessions covering many other considerations than simply that of risk.

Asked by the Chairman as to whether the companies could withdraw owners' risk rates, the witness said that he thought that being named in the Acts of 1894 they had become statutory. Further, as this would lead to an increase in the charge, the change could be challenged before the Railway Commission.

### Joint Claims Committee.

Sir Charles remarked that he wished to remove a possible misapprehension from the minds of the Commission. It was put to Mr. Marwood that "the existence of the Joints Claims Committee tended to eliminate one of the advantages of competition," to which he assented. The witness thought, however, that it would have been more accurate to say that it tended to eliminate one of the *evils* of competition.

The companies had allowed traders to become their own insurers on very liberal terms. Some witnesses had said that the risk was practically not insurable as the necessary data were not available. But the trader knew his losses, and by keeping records could furnish the proposed insurer with precise information. Inquiries had been made of Lloyd's, and it was found to be no unusual thing to insure goods whilst in transit, but such business was done through brokers. Further inquiries showed that the whole of the goods any trader dispatched by rail throughout the year could be insured, the premium varying with the class of goods.

Some traders recognised that in sending goods at owner's risk rate they became their own insurers, and so bore the loss. Other traders, however, wanted their cake and to eat it too. These, availing themselves of competition, urged their claims, and said that if they were not paid the traffic would be diverted to another route. Some of the latter were paid, and thus a condition of undue prejudice was set up against the first-named class of trader and of undue preference to the second. The evil could only be met in one of two ways, *i.e.*, by the companies accepting the position that owner's risk rates were to be treated as company's risk rates, which would mean a large loss of revenue, or, alternatively, agreeing amongst themselves that the abuse of owner's risk rates should be stopped by all companies.

Railway companies were, like other business houses, entitled to overhaul their methods and put their house in order from time to time. The refusal to pay such claims, and the establishment of the Joint Claims Committee, were not the result of working agreements, as they were in force before the latter came into effect. They were brought into being for the double purpose of preventing loss of revenue and of putting an end to the illegal preference and prejudice which had arisen. Sir Charles himself initiated the idea in the General Managers' Conference at a time when there was no prospect of any working agreement between his company and the Great Western.

It had been stated that when claims came before the Joint Claims Committee they were always declined, the companies practically preventing each other from making reasonable concessions. That this was not so may be judged from the fact that during the year 1913, the London and South-Western Company submitted 888 claims, of which 879 related to owner's risk rates, to the Committee, of which 793 were paid in whole or in part. In respect of the 95 claims declined, the amounts were so small that a summons in the County-court could have been taken out. This was typical of other railways, too, as fourteen other companies had reported to witness their experience, which showed that out of 53,930 claims, 50,030 were paid in whole or in part, and out of the remaining 3900, only 96 were the subject of legal proceedings.

Questioned by Mr. Balfour as to the charge made by several witnesses, that when a trader persevered with his claim the representatives of other companies came and threatened him, Sir Charles said that this might be done, but only after continual trouble with the trader and when matters reached a crisis.

### Increase in Rates.

This matter being *sub judice*, the witness did not wish to deal with it fully, but he pointed out how prices of commodities, except the price of transportation, had increased in every direction. After referring to the inquiry as to an increase in rates now in progress in the United States, and to the statement by Mr. Broodbank—a previous witness—that the Port of London Authority had increased its rates by 7½ per cent., or nearly double the increase made by railway companies in their charges, Sir Charles gave some particulars of certain items that had increased in cost since the last revision of rates in 1893. On the London and South-Western Railway rates and taxes were, in 1913, £133,602, or 109 per cent. higher; coal, £210,163, or 58 per cent.; water, £5000, or 20 per cent.; steel rails, £18,792, or 42 per cent.; chairs, £9960, or 43 per cent.; and sleepers, £15,625, or 63 per cent. These were representative items and were capable of being extended. The witness also compared the highest and lowest prices in 1893 with those of 1913 in copper, tin, rape oil, linseed oil, and deal battens, and then showed that while steel rails cost £6 10s. per ton, the increase in the rate in carrying them from Newport, Mon., to Redbridge would be but 5d. per ton; copper at £65 per ton would pay an additional 1s. per ton from South Wales to Eastleigh; and block tin at £175 per ton also 1s. from Neath to Eastleigh. The carriage for grain in 4-ton lots for forty miles had been increased from 5s. 8d. to 5s. 11d., and wheat, the market price for which was from 30s. to 35s. a quarter, would cost ·6d. per quarter more; but if in 6-ton lots, ·4d. per quarter.

The question of labour was not dealt with by the witness, as its increased cost was the main subject in the litigation pending as to the 4 per cent. increase. Answering the Chairman, Sir Charles said that this 4 per cent. would bring in an additional £45,000 to the South-Western Company.

### A Tribunal to Fix Reasonable Rates.

The witness opened this point by quoting from the report of Mr. Russell Rea's Committee on Railway Agreements and Amalgamations, wherein it said, "For these reasons we do not think it desirable that a general power of deciding whether existing charges are reasonable should be given to any tribunal." If a tribunal were to fix rates the maxima laid down in the Acts of 1894 must go, as if the companies could prove that rates higher than the maxima were reasonable the companies would be entitled to charge them.

Sir Charles was about to quote what previous Commissions and Committees had said, when the Chairman remarked that that was unnecessary, as the present Commission had all the papers. The witness was, however, allowed to quote the following from the report of the Royal Commission of 1867: "It must be recollected that the companies are entitled to derive a benefit from the rates assured to them by Parliament, and the course suggested would be tantamount to transferring this benefit from the companies themselves to individual traders, in order to add to the profits of their business, established with a full knowledge of the system of railway rates."

Rates are now fixed with reference to a multitude of circumstances within the knowledge of experienced officers who deal with them. The relation of each rate to other rates over similar distances had to be considered, and no amount of evidence laid before a tribunal could equip it with the knowledge or experience which now had to be brought to bear upon the fixing of a rate. Witness did not suppose that the Railway Commission, without a staff of hundreds or even thousands of experienced men, could possibly cope with the proper consideration of rates, if any large number of applications were made to it by traders.

### Alleged Fictitious Analysis of Rates.

Any analysis of a rate into its elements of conveyance, service terminals, station terminals, collection and delivery, must necessarily be artificial, and more or less a matter of guesswork. When the great bulk of the present railway rates were fixed there was, generally speaking, no specific authorised charge for terminals, although the companies successfully maintained their right to charge a reasonable sum. The position, therefore, when the obligations of the Acts of 1873 and 1888 came into operation, was that there was no absolute statement, in any of the records of the companies, how their rates were made up, and the compliance with the obligation to dissect the rate had to be upon lines of allocating some portions of the total rate to the different headings mentioned in the statutes. Just because this allocation necessarily had to be artificial, and without direct reference to anything in the minds of those by whom the rate was fixed, it was quite unfair to describe it as a fictitious analysis.

At this point the Commission adjourned until the following morning, on which day both Mr. Jackson and Sir William Plender were absent. Sir Charles Owens then proceeded to deal with the subject of

### Classification.

After quoting what Mr. Russell Rea's Committee said thereon, the witness remarked that there had been one case where the Board of Trade had made a change in the statutory classification of an article. This was connected with bananas, the character of which had been so altered since 1893 as to be regarded as a new article which could therefore be classed by the Board of Trade. Sir Charles also remarked that he would deprecate, in the interests of traders, such a revival of the irritation caused by the revision of rates and classification in 1888–1892, that a review of the classification now would entail.

The present maximum classification was, in many respects, the result of compromise between traders and the companies. In view of the power of the Board of Trade to add to the classification on the application of a railway company or a trader it was contended that it was unreasonable to suggest that the classification should be made subject to any new tribunal whatever. To change the classification was equivalent to changing a rate and interfered with the powers conferred on railway companies by Parliament, and by Parliament alone should those powers be altered. It had probably been overlooked that were such a tribunal in existence it would be possible for the companies to get articles transferred to higher classes.

The Goods Managers' Conference meets quarterly and to it were submitted any classification questions which were of prime importance. In many of the complaints made before the Royal Commission it was to be observed that formal requests to the companies had not been made or that the trader had accepted as final the decision of a local officer.

On Mr. Balfour pointing out that Mr. Russell Rea's Committee said—Paragraph 95—that a legal power to amend the classification, as well as to add new articles to it, might be given to the Board of Trade, Sir Charles Owens said that that was qualified, by the words in the remainder of the paragraph, to apply to articles in which circumstances had changed. As this report had, in the previous sentence, deprecated a revision of rates, it was natural to assume that Mr. Russell Rea's Committee would deprecate a revision of the classification, as that meant the same thing.

Answering Lord Derby, the witness said that Subsection 11 of Sec. 24 of the Act of 1888 gave the Board of Trade power to add to the classification, and he did not think there was any appeal therefrom. As an illustration of where circumstances had changed, Sir Charles quoted English and foreign pressed hay. The former filled a

truck with 2½ tons, but the latter gave 4½ tons. That fact would, in his personal opinion, be sufficient to justify an addition to the classification.

Here the Chairman asked the witness an important question. Lord Loreburn said, "Has the fact that increases are liable to have to be justified before the Railway Commission had any restraint on the companies lowering their rates experimentally?" To which Sir Charles replied, "Undoubtedly." This led to the Chairman observing, "That is a very important point, and we must come back to it when we have the pleasure of seeing you again."

### Closing Ledger Accounts.

The right of a railway company was to prepayment of its charges, and if it did not insist upon that it had still the right to be paid the charges before parting with the goods carried. In the case of traders whose business was of sufficient magnitude, these rights were waived, and the business was done on a system of credit and periodical settlements. This arrangement was the subject of a written agreement, one of the terms of which was that the account was to be paid without question, any errors to be adjusted afterwards. Notwithstanding this agreement, it was the frequent practice of traders to make large deductions, not only in respect of items they disputed, but in settlement of claims which they believed to be reasonable. In some cases where a trader persisted in disregarding to an unreasonable extent the conditions upon which he obtained credit, the companies did, no doubt, indicate that unless the conditions were observed the credit would be closed. But that there had been a systematic exercise of this right by the companies, or that it had become even more frequent of late, Sir Charles did not for a moment believe. It should also be known that a trader, despite the agreement, was allowed, to a very large extent, to make deductions, and the companies were very far from insisting upon strict compliance with the conditions on which credit was originally given.

In answer to the Chairman, the witness said that joint action as to closing credit accounts was only taken after due consideration by the heads of the department. No local official would take any such action.

### Alleged Absence of Competition.

It was not accurate to assume, because certain companes had entered into working arrangements, that competition no longer existed. It certainly did exist between the companies comprising the various groups formed by recent arrangements. Wherever such groups came into contact they must necessarily continue to compete. It was important to remember that Great Britain was an island, with numerous excellent ports all round the sea coast. The constant service of steam vessels running according to a regular timetable between the various ports constituted an important and far-reaching competition against railways. Coupled with this sea service was a rapidly developing service of road motor traction which brought traffic to and delivered traffic from the sea-going vessels. At Poole, for instance, there was a sea service to and from London, and a service of motor wagons covering a radius of twenty miles, including Bournemouth; so that at the latter place, where it might be assumed that the London and South-Western Railway had a monopoly, there was the keenest competition.

There was competition between districts. Although the London and South-Western and Great Western had a working agreement, the former did its best to develop Bournemouth, Sidmouth, and other places; the Great Western Railway did the same with the Cornish Riviera. In the development of the fruit-growing industry around Swanwick in Hampshire—an entirely non-competitive district in itself, yet competitive in the highest degree with other districts—special rates for the conveyance of manure and of strawberries had been quoted, and every possible facility in the direction of rapid transit arranged. The result was that in the season of 1913 no less than 2,825,000 baskets of strawberries were forwarded from that district, requiring, during the height of the season, approximately fifteen special trains and a total of about 630 vans daily.

Sir Charles added that working arrangements were only in relation to competitive traffic, and that non-competitive stations were not neglected. He would also draw attention to the retail character of railways now. Shopkeepers held a smaller stock and kept more money in their pockets, because they could wire to London for any particular article in the afternoon of one day and were nearly sure to have the same delivered by the railway company the following morning.

As illustrative of the expedition shown, the witness gave particulars of the shed traffic dispatched from Nine Elms on May 11th last. There were 9935 consignments, consisting of 46,708 packages. The average weight per consignment was 4 cwt. 1 qr. 2 lb., and 3 qr. 18 lb. per package. The gates at Nine Elms were closed at 7 p.m., and yet the Southampton portion of these goods was sent out in three drays by 7.30 the following morning, the Exeter portion at 8.10, 8.20 and 8.30, and the Plymouth at 8.15 and 8.20. It must, in this connection, be remembered that Exeter and Plymouth, being competitive with the Great Western, were subject to the working agreement between the companies.

### Demurrage and Siding Rent.

After explaining the evils of the delay in unloading and loading wagons, and of how competition had led to these evils being winked at, Sir Charles pointed out that undue prejudice was shown towards the trader who paid, and undue preference to the trader who was allowed to evade payment. The suggestion that delays should be averaged was one that had often been made, but as it would imply that the maximum period of free detention should be allowed to every truck, it could not be entertained. It was to the interests of the companies to get rid of traffic, otherwise sheds and lines would be blocked. One Scottish company had been able to make 30 per cent. more trips with its wagons since demurrage was enforced.

Answering Lord Derby, the witness said that the companies generally unloaded their own trucks on the same day that they were received. He would not agree that when a trader unloaded his wagons promptly he was helping the companies; he was only doing what was expected of him.

Mr. Balfour questioned the witness as to demurrage being incurred when the wagons were not accessible—Mr. Ward in THE ENGINEER, May 1st—and, in reply, Sir Charles suggested that this was due to the trader's delay in sending to unload the wagon which had meanwhile been shunted away to make room for some other trader's truck.

### Common User of Wagons.

This was a subject proposed by Mr. Thorne—THE ENGINEER, May 8th—and one obviously attractive, but not at all new. It was not easy for those not intimately acquainted with the working of railway traffic to appreciate the difficulties in the way of its general adoption. In the first place, between two given centres there might be, and often was, a large disparity between the bodies of traffic flowing in each direction. For instance, the London and South-Western Railway received twice as much traffic as it sent away. This necessitated a certain amount of empty running. Then there were private owners' wagons which had to be returned empty.* There would naturally be an attempt in times of stress on the part of the companies to retain wagons belonging to the other companies, but if a comprehensive plan could be devised the companies would be the first to benefit by it.

Mr. Prothero drew attention to the fact that a Committee of the Board of Trade Railway Conference suggested that there should be a scale of maximum times allowed for conveyance of private owner's trucks. Sir Charles could not say if anything had been done in this; possibly some of the northern companies might have made a move. The witness was very severe on the evils of the private owner's wagon, and told Mr. Balfour that he thought it would pay the companies to buy them all up. The private owner would then have to cease to build. He did not think there was anything in the statement that collieries must have their own wagons for fear of a scarcity of railway-owned wagons; such a scarcity was unlikely.

### Tribunal for Differences and Disputes.

This question, being a legal one, would be dealt with more fully by a later witness, but Sir Charles was authorised to say that the Railway Companies' Association fully accepted the suggestion of the Board of Trade Conference, endorsed by Mr. Russell Rea's Committee, as to the hearing of minor complaints by the Registrar of the Railway Commission. Arbitration was unsuitable, as a decision had no binding effect beyond the one case under consideration and did not establish a precedent. Railway cases were not limited in effect to the point under review, but might affect railway rates and conditions all over the kingdom.

### Conciliation Proceedings.

Sir Charles Owens suggested that sufficient regard had not been had to the valuable work done by the Board of Trade under the conciliation powers of the Act of 1888. From the report dated November, 1912, it would be seen that in twelve years 2141 cases of complaint were made, of which 708 were settled more or less to the satisfaction of the complainant, in many cases through concessions voluntarily made by the companies. There were 635 cases "not followed up by the complainants," and in these it was fair to assume that they were satisfied with the explanations given. In 797 the complainants were not satisfied. It was important to remember that no cost whatever, save that incurred in attendance, need be incurred in an application to the Board of Trade. It is not, then, reasonable to describe a course of action as "useless" which has produced such excellent results.

### Further Powers to Light Railway Commissioners.

This was Mr. Moon's and Mr. Steward's proposal—THE ENGINEER, December 5th, 1913, and January 23rd, 1914—and Sir Charles Owens desired to express on behalf of the Railway Companies' Association its concurrence in the suggestion that the Light Railway Commissioners might well have the right to entertain and deal with applications for further powers of a minor character, or, alternatively, it would be prepared to see the powers of the Board of Trade so extended. Asked as to which body he preferred, Sir Charles said that he preferred the Light Railways Commissioners, as then the Board of Trade would still remain the administrative body.

Having regard to the difficulties of getting a second reading of Bills in Parliament, the companies were now tempted to postpone applications for powers to carry out necessary works, and that was a bad thing for the public. Could they go to the Light Railway Commissioners, they would do so oftener, and that would be better for engineers, contractors and labour.

Asked why it was necessary to go to Parliament in cases where land was bought by private agreement, Sir Charles said that where a bridge replaced a level crossing, it was necessary to get parliamentary powers to stop up the right of way. In a case, too, where some coal sidings had been put down on land privately bought, the London and South-Western Railway Company found itself liable to damages for causing a nuisance—an action that could not lie if parliamentary sanction had been obtained.

### District Conferences.

Whilst Sir Charles was a firm believer in the closest personal relations between railway officials and traders, he thought the conditions in this country and Prussia were so dissimilar that the conferences held in the latter country, where all the railways were under one administration, would not be possible in the United Kingdom, which was a much smaller country, having its railways administered by a large number of corporations. He would remind the Commission that no action had been taken as to the recommendation of the Board of Trade Conference with regard to Advisory Councils.

Speaking for the London and South-Western Railway, he would say that the district officers attended markets, &c., and so kept in touch with traders, and the chief goods manager or his assistants were always willing to give interviews in London. The superintendent in Southampton and the one in Plymouth were members of the local Chambers of Commerce, and the Great Western and Midland companies' respective solicitors informed him that their representatives were encouraged to join the Chambers of Commerce in their towns. In reply to Sir Henry Primrose, the witness said that such meetings would correspond with the Advisory Councils of Prussia.

### Nationalisation.

No definite pronouncement on this subject had been made by the Railway Companies' Association. It must be remembered that this was a voluntary body, and that all the railways were not members. No decision it arrived at, even if unanimous, bound those companies, the representatives of which were not present. Further, no chairman—and all the members were chairmen—would presume to commit his company until the shareholders had been consulted.

Sir Charles was, however, prepared to give his own views on this subject, and he handed in a statement upon which he will be examined at the next sitting.

### Unification.

It was difficult to compare British railways, with their extensive ramifications and immense variety of business, with the Metropolitan Water Board, the business of which was in one locality and absolutely homogeneous, or with the Port of London Authority, the operations of which were confined to one river. No such close personal touch was possible with regard to a railway system extending over many hundred miles as was possible with a dock board and its docks.

It was difficult to see how any necessary new capital could be expected to be provided by those who, while retaining ownership, had no effective control over that on which the capital would be expended. It was appalling to think of the fall in the value of railway stock there would be if it were announced that some body, not responsible for providing the finance, was to govern the railways.

Sir Charles also drew attention to the fact that Subsections 1 and 2 of Sec. 23 of the Port of London Act of 1908, which allowed the Board of Trade, if it was satisfied that the revenue in any year was not likely to be sufficent to meet the charges, to make an order to increase the dock dues accordingly, but within the maxima.

The Commission then adjourned until the 24th inst.

* This is hardly the point Mr. Thorne made. He showed, for instance, how convenient, when a vessel was being unloaded, it would be if the first wagon available could be used instead of the wagons having to be sorted out or one fetched from the depôt so as to get one belonging to the particular company for which the consignment was intended. —Ed. THE E.

## INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

### No. I.

AN extensive programme, both from the technical and social points of view, had been arranged this year for the annual Convention of the Incorporated Municipal Electrical Association, which has been held in Birmingham during the past week. No less than four hundred members and visitors notified their intention of attending, a number which constitutes an easy record. The proceedings opened on Tuesday morning, June 16th, when the Association was welcomed by the Lord Mayor of Birmingham.

The business part of the meeting was then begun by Mr. R. A. Chattock, the City Electrical Engineer at Birmingham, who delivered his presidential address. The President first of all remarked that at the last annual Convention private meetings were held, at which there was considerable criticism of the model general conditions of contracts designed by the Institution of Electrical Engineers and the British Electrical and Allied Manufacturers' Association. The fight was really between the Incorporated Municipal Electrical Association and the British Electrical and Allied Manufacturers' Association, and as no agreement was come to, the conditions which had recently been issued by the Institution of Electrical Engineers had not received the approval of the Incorporated Municipal Electrical Association. The result was that these model conditions, which were at variance with the ideas of municipal station engineers in many respects, were now being put forward by manufacturers, with the authority of the Institution behind them, and buyers were being obliged to accept them without much hope now of negotiating alterations. Mr. Chattock reminded members of the Association that a more favourable result would have been obtained if they had adopted the carefully considered recommendations of the Council of the Incorporated Municipal Electrical Association made twelve months ago instead of rejecting them, as they did. With regard to the Incorporated Municipal Electrical Association Electric Lighting Bill, which, among other things, deals with the contentious question of municipal wiring powers, there was recently, Mr. Chattock said, a very strong prospect of an agreement being come to with the Electrical Contractors' Association, but the influence of certain members of the Contractors' Association had been too strong, and matters were now no more forward. Mr. Chattock is in a very impartial position in this matter, inasmuch as, although he has full wiring powers in Birmingham, he has never found any necessity for putting them into force, being fortunate enough to have very competent electrical contractors in his district. At the same time, he takes the point of view that there are many other smaller towns where these conditions do not prevail, and that it would be in the common good for these to have full wiring powers to exercise if need be. On the general question he is convinced that the Electrical Contractors' Association exaggerates the quantity of work that it would be possible for a municipality to undertake, even if the powers were put into force, and maintains that, after all, these powers merely assist in eliminating jerry wiring, and that that is the sole object of municipal station engineers. Moreover, he believes that supply undertakings cannot do without electrical contractors, and maintains that the idiosyncrasies of a few engineers, and possibly also a few contractors, should not be allowed to interfere with the well-considered policy of the Association in putting forward a scheme that all supply engineers, and, he believes, all broad-minded contractors, consider to be in the general interests of the industry. Mr. Chattock also made reference to the work now being carried out by the Electric Vehicle Committee of the Association, which has organised a demonstration of some dozen electric

vehicles. Hitherto the expenses of this Committee had, he said, been met out of the Association funds, but he expressed the view that, as the work being done was of a general propaganda-like character, funds should be subscribed independently. As a matter of fact, municipal supply authorities and manufacturing firms had been asked to subscribe £3 3s. each towards the £200 required during the next twelve months, and there had been a very liberal response.

A practical suggestion was made to get over the difficulty created by the abandonment of the Industrial Committee of the Institution of Electrical Engineers. This body, when it was constituted some twelve months ago, was looked upon as being likely to perform most useful work in a direction for which there existed no tribunal. When, however, it got to work, it was found that under the Articles of Association of the Institution of Electrical Engineers matters into which any flavour of politics entered could not be touched, and as, at any rate in the electrical industry, it was difficult to find an industrial matter into which some form of politics did not enter, the Council of the Institution disbanded the Committee, much to the general regret. Mr. Chattock suggested that all associations connected with the electrical industry should form a central association to carry out the work originally intended for the defunct Industrial Committee.

After disagreeing with Mr. J. J. Newbigging, president of the Manchester District Institution of Gas Engineers, who has recently argued in favour of the combined control of municipal gas with electric supply undertakings, Mr. Chattock dealt at some length with the question of centralisation of electric supply undertakings in this country. Signs, he said, had not been wanting for some years past that the question of bringing isolated electric supply undertakings under one system of supply had been occupying the attention of electrical engineers. Especially had this been the case in London, where attempts had been made to amalgamate the various companies by the formation of a central supply company. The London County Council was also strongly in favour of centralisation of all supplies, whether company or municipal, whilst in the provinces the larger municipalities had been extending their boundaries, and incidentally taking over the electric supply undertakings belonging to the areas incorporated, with distinctly beneficial results to themselves and to the areas taken over. All these instances were, remarked Mr. Chattock, steps in the right direction, though he added that we were as yet a long way off the goal where it would be possible to obtain all over the country, and at one rock bottom price, a supply of electrical energy for any purpose. Our manufacturers could only hold their own in the markets of the world if they could produce as cheaply as possible. Other countries were recognising this. America and Germany were establishing centrally controlled systems of supply which could not fail to have a far-reaching effect upon their commercial welfare. The larger municipalities in this country had pointed the way, and now, continued Mr. Chattock, it remained for Parliament to tackle the question of nationalisation. either by means of a Government department or a public board of management, or a private company subject to limitations as to dividends and prices. Until some such scheme was brought into operation it was useless to expect any marked reduction in the cost of producing and distributing electrical energy below that obtaining in the large power stations now operating in this country. It was advocated that large bulk supply power stations should be installed in various parts of the country, and as soon as the distributing trunk cables were installed the small generating stations throughout the country should be at once shut down and utilised as substations. The existing methods of distribution might be adhered to, and the services of the engineers at present in charge of the various distributing areas must, in Mr. Chattock's opinion, be retained in the interests of efficiency. The main distribution should be carried out wherever possible by means of overhead trunk mains, and wayleaves should be compulsorily granted on reasonable terms, otherwise it was probable that the cost of obtaining them would very nearly kill the saving on overhead trunk lines compared with underground cables.

It was pretty evident, however, added Mr. Chattock, that Parliament had its hands so full at present that there was no hope of any move being made in this direction, and he suggested that all industrial centres, in their own interests, should meet together and discuss the matter, and if possible formulate a satisfactory scheme to be brought before Parliament.

Following the presidential address, Mr. W. A. Vignoles, Chief Electrical Engineer to the Grimsby Corporation, read a paper on "The Commercial Development of Electricity Supply in Moderate-sized Towns." The paper discussed the problems to be met with in the supply of electricity in towns of about 100,000 inhabitants, and the conclusions reached were, naturally, based upon Mr. Vignoles' experience in his own town, which has a population of about 77,000. There are docks and a large fish market—the largest in the world, as a matter of fact. There is also a large export trade in coal, while timber and general merchandise are imported. Factories are few in number, though there are the usual miscellaneous workshops incidental to a shipping town, and a few large sawmills. The latter, however, usually employ steam for producing power, burning their wood refuse instead of coal. Incidentally it is of interest to note that Grimsby has no special powers for selling apparatus to consumers.

Mr. Vignoles advocated (1) showrooms where electrical fittings, heaters and cookers could be seen in use; (2) periodical exhibitions or demonstrations serving the same purpose; (3) advertising; and (4) personal canvassing. In Grimsby arrangements were made to sell apparatus through contractors, and thus the necessity for a Corporation showroom was obviated. The engineer in one town of about 100,000 inhabitants recently stated that his showroom cost him £600 per annum, excluding canvassing staff, but in Grimsby excellent results had been obtained by advertising with considerably less expenditure, the figure in 1913–14 being only £250, which, on a turnover of from £20,000 to £24,000, could not, it was urged, be considered extravagant.

The paper suggested that the Incorporated Municipal Electrical Association should appoint a Committee with full powers to confer with the Electricity Supply Publicity Committee in London, or any other body, to endeavour to formulate some scheme by which a co-operative system of publicity could be put on foot for the benefit of electricity supply generally. Municipalities were somewhat handicapped, it was explained, owing to restrictions of the Local Government Board, objections having been raised to the spending of money on advertising. A recent ruling of the Board, however, was to the effect that advertising literature might be purchased, but that authorities had no power to subscribe to the funds of an association organised on the lines of the British Commercial Gas Association. A different constitution, it was suggested, might get over the difficulty; if not, the sooner the Incorporated Municipal Electrical Association Electricity Bill, in which there was a clause dealing with this question, was passed, the better.

All the details of a publicity campaign were discussed in the paper, but one point might be specially referred to, and it is one which has been a hindrance to electric supply in many towns, and that is, hesitation on the part of a committee in spending money to extend mains before consumers had actually been secured. This policy was condemned by Mr. Vignoles, and a certain amount of commercial risk was recommended in the matter. The asking of guarantees from consumers was also condemned, except in special circumstances, and there were, it was pointed out, cases almost without number in which prospective users of electricity had gone over to gas rather than guarantee any special consumption per annum.

The development of electric cooking was, naturally, referred to, as was also the difficulty that, owing to the comparatively small market, manufacturers of electrical cooking apparatus were putting apparatus through the shops in dozens instead of in hundreds. To improve upon this condition of affairs it was suggested that a number of undertakings should combine together and adopt a particular make of cooker, so as to enable output in large quantities to be carried on, with, consequently, considerably lower prices.

The second part of the paper dealt with the financial control of municipal electrical undertakings, and here it was recommended that the whole control—business-getting, engineering, and finance—should be placed under one supreme head, and the department kept entirely self-contained, without any intervention, as was frequently the case, from the borough treasurer's department. The contribution of profits to the relief of rates was not upheld by Mr. Vignoles, and he found no difficulty in referring to instances where large sums of money were dealt with in this way, notwithstanding that there were large quantities of obsolete plant in the engine-room. All the profits, in Mr. Vignoles' opinion, should be kept in the undertaking, with a view to reducing the cost to the consumer to the lowest possible figure.

A general review of the present commercial position of electricity supply showed, he continued, that undertakings were passing through a period of great development, where an energetic and pushing policy had been adopted, and the outlook for the future was exceedingly bright, and he added that the use of electricity for power would undoubtedly continue to grow at a rapid rate; the demand in that connection was, he said, so well established that in his paper very little had been said about it. It must not be assumed, however, that this branch of business could be left to look after itself; on the contrary, it should be carefully tended and any inquiry closely followed up, otherwise business might be lost. It had been seen that the sale of electricity for heating and cooking at ½d. per unit, or at least on a rateable value system of 15 per cent. and ½d., was a sound proposition, while the supply for charging vehicles should bring in a good revenue in the course of a year or two. There were financial rocks ahead of some undertakings, especially where the change from continuous current to three-phase generation was made. This change, however, was already desirable in many towns, and would be to the advantage of the undertaking in the long run. The difficulties should therefore be faced as soon as possible, and if a conservative policy had been adopted and profits devoted to the strengthening of the financial position of the undertaking, this would be in a position to face any losses that might occur during the first year or two after the change.

There was a long and, not unnaturally, lively discussion, as the subject was one upon which councillors could air their views. The chief point brought out by this class of member of the Association was as to the policy of allocating profits to the relief of rates, upon which, presumably, there will always be differences of opinion. It is not a little interesting to note the variance of view—as, for instance, between Liverpool, Sheffield and Glasgow, to mention only a few. At Liverpool, where a certain notoriety has been achieved in connection with high prices for current, the Committee believes in transferring large sums from the profits to relieve the rates. At Sheffield and Glasgow, on the other hand, the opposite policy is pursued, viz., sell current at the lowest possible price and so assist the general progress of the town, not so much from the local point of view as from the broader point of view of permitting of more effective competition with foreign firms. This was all-important in the case of Sheffield. So far as the general tone of the discussion went, there would seem to be a continually growing feeling among committees that the wisest course is to keep all profits in the undertaking, and so strengthen the financial position to the utmost possible extent.

The suggestion that a central publicity organisation should be formed by the Association was welcomed with enthusiasm all round, and the question is to be raised at the annual general meeting to-day (Friday). At present, however, there seems likely to be some difference of opinion as to the details, whilst a few engineers fail to see any good in creating this organisation—albeit, they are strong supporters—for the reason that local authorities are somewhat severely handicapped by the Local Government Board as regards expenditure. Money may be spent on literature, as it represents "goods supplied," but no funds may be devoted to exhibitions and so on. These restrictions only apply to cases where a Local Government Board auditor is involved. Undoubtedly a new era seems to be dawning in the electrical industry in the direction of cooking and heating, especially when it is being found that electric cookers are being taken up in such a place as Poplar. Indeed, several engineers express themselves to the effect that they regard lighting more or less as a by-product, and would take on a lighting consumer at a loss for the sake of getting the heating and cooking load.

There is still a very strong feeling that the Association should press forward its Bill, although many would agree to the withdrawal from it of the full sales and wiring powers for the sake of obtaining hire and hire purchase powers, which it is felt are essential. Contractors do not, and are not expected, to hire out apparatus, and yet the municipalities are really prevented from doing so because of the dispute as to the sales and fittings.

Visits to various works were paid on Tuesday afternoon, and not the least interesting feature of the afternoon's work was a parade of electric vehicles at Witton. Some dozen vehicles were on show, and it is generally felt that the finest piece of co-operative work carried out in the electrical industry had been the creation of the Electric Vehicle Committee, which was the outcome of a suggestion at last year's convention in London.

The annual dinner was held in the evening.

On Wednesday a visit was made to Coventry, when, after a welcome by the Mayor, the whole morning was given up to the discussion of a paper by Mr. S. E. Fedden, Chief Electrical Engineer to the Sheffield Corporation, on "Design and Operation of Modern Boiler-house Plant." The main points to consider in the laying down of a steam-driven power station were, Mr. Fedden explained, (1) adequate supply of water for condensing purposes; (2) ample facilities for dealing with ashes; (3) good accommodation for getting in and storing coal. No. 1 was not dealt with, it being regarded as beyond the province of the paper. No. 2, however, was becoming a very serious source of expense and concern in large cities, because of the difficulty of obtaining tips within a reasonable distance of the station. In Sheffield the cost of carting had increased no less than 40 per cent. within the last few years, and it had been found necessary to lease a valley adjacent to the power-house, and to install a ropeway some 200 yards long, capable of dealing with 20 tons of ashes per hour. The preliminary investigation as to cost showed that to dispose of the ashes by railway would cost 2s. 9½d. per ton, to cart them away would cost 1s. 11d. per ton, whilst the ropeway method costs 1s. 3d. per ton.

In the main the paper was a description of the boiler equipment of the Neepsend power station of the Sheffield Corporation, which is arranged on the plan of having a high-level siding, so that the trucks come in straight off the railway over the top of the bunkers.

On the question of live steam feed-water heaters many engineers argued, said Mr. Fedden, that warming the water by live steam was economical and saved coal. He himself, however, had not yet been convinced on this point, although he conceded that any loss incurred by heating the feed water by steam was well and amply repaid in the saving of repairs to the economiser and boiler tubes, and therefore was a saving of capital expenditure which would otherwise be required for extra economisers and boilers as spares. Nevertheless, he had installed live steam feed-water heaters, which were fitted with indented tubes, so that fluid passing through the tube was thoroughly broken up and diverted into contact with a large amount of impinging surface. It was claimed that a tube so indented increased the heat transmitting properties in excess of an ordinary plain round tube, as the breaking up of the centre core of the tube increased the velocity of the steam through it and kept the steam in active contact with the copper.

Suction plant for dealing with ashes was about to be put in for all new boilers, and eventually for the old ones. Only a few of these plants were in use in this country, although there are a number in America. At the Dunston power station of the Newcastle-upon-Tyne Electric Supply Company there was one, and another was working at the West Ham Corporation Electricity Works. Manufacturers' opinions, however, seemed to differ very considerably as to the means of conveying the ashes and gritty matter by pipes to the receiving chamber. Some recommended a blower of the Roots type, while others recommended a continuous suction by means of a motor-driven fan.

As to the selection of boiler, Mr. Fedden said that he considered, with his present knowledge, that the best overall efficiency and least maintenance cost was obtained by running the following combination:—Water-tube boilers; economiser; chain grate stokers; induced fan draughts; at 25 lb. of coal (rough engine slack) per square foot grate area; evaporation per square foot of heating surface, 5.25 lb.; in-going gases to economiser, 450 deg. Fah.; out-going gases from economiser, 300 deg Fah.; though it was quite possible to burn the same class of coal up to 30 lb. per square foot of grate area with good economy.

With regard to the rating of water-tube boilers, it was a matter of common knowledge that the rate of evaporation in the neighbourhood of the furnace was very high compared with other parts of the boiler. As the rate of combustion increased so did the rate of evaporation with the same size of boiler. Mr. Fedden called attention to the fact that manufacturers had put forward for different capacities similar sizes of boilers, but with stokers having a larger grate area, so that some standard as to rating should be adopted. The standard adopted by the electric supply department at Sheffield was that the normal evaporation should be obtained by burning 25 lb. per square foot of grate area with a chain grate stoker burning engine slack. There had lately been installed at Sheffield some 8ft., Class E, underfeed stokers to two water-tube boilers fitted with both forced and induced draught. The boilers were specified to evaporate 35,000 lb. of steam each from and at 212 deg. Fah. The combination was as follows:—Water-tube boilers; economisers; underfeed stokers; induced draught fan, H.P. on load 55, giving 1.3in. draught; forced draught fan, H.P. on load 30, giving 2in. draught; normal coal per square foot of grate area, 33.5 lb.; evaporation per square foot of heating surface, 5.25; in-going gases to economiser, 518 deg. Fah.; out-going gases from economiser, 290 deg. Fah.

The results were:—Burning up to 47 lb. of coal per square foot of grate area under the above working conditions the boiler evaporated 58,000 lb. of water per hour from and at 212 deg. Fah., but the heat of the brickwork was so intense after the first hour's run that the rate of burning was reduced to 38 lb. per square foot of grate area. The superheater was not designed to deal with this large amount of steam, the temperature being reduced from

150 deg. Fah. under normal conditions to 110 deg. Fah. The author thought that this combination had a great future before it, and its limit would be determined by the ability of the brickwork, &c., to withstand the intense heat generated in the furnace with the above conditions.

Mr. Fedden is a believer in mechanical induced draught, and strongly advocates that care should be exercised to install a fan or fans capable of dealing with the worst atmospheric conditions and of dealing with sufficient gases for the maximum possible overload of the plant. Regarding the hot *versus* cold air systems of induced draught, it would appear that the latter should be the more economical, owing to the smaller power said to be required to deal with the lesser volume. The author investigated this matter some three or four years ago, but could not satisfy himself that there was any very great benefit to be derived, besides which the cold air injector was expensive to manufacture and renew.

A decision with regard to the type of mechanical stokers was difficult to arrive at. The ideal stoker should be able to deal with clean nuts or smudge, should be able to get to full duty from banked fires in the shortest possible time, should be capable of doing 50 per cent. above its normal duty for short periods in case of emergency, should consume all combustible matter fed on to it with the most efficient percentage of $CO_2$, should be smokeless under all conditions, besides which it must be strongly built, reliable, and easy of access for the repair of the working parts or the renewal of the bars. These conditions were, of course, difficult of attainment in one stoker. For small grates there were many good and reliable stokers on the market in Britain, but with the larger grates now required the choice was reduced down to two or three. The chain grate had in the past done yeoman work, but it had its weak points, such as the difficulty of burning mixed slack and the difficulty of keeping an even-covered grate, the prevention of unburnt coal being dumped, the extra labour in handling riddlings which filtered through the grate before coking took place, and it was unable to comply with many of the requirements set out above. However, if when improvements now being carried out on it proved satisfactory in working, no doubt it would come much nearer to the ideal. The underfeed stoker, which had recently been enlarged and strengthened in its mechanical parts, had proved itself, from the author's experience during the last eighteen months, most satisfactory, and had complied more nearly with the conditions before mentioned. Mr. Fedden said, therefore, that he considered that the safest arrangement for a large boiler-house was to install a certain proportion of the old reliable chain grate, which had proved satisfactory over a long series of years, and the remaining portion of the newer type, which, while being excellent from results obtained in a comparatively short time, had yet to prove its superiority over a longer period.

With regard to the suggestion made from time to time lately that large electric power stations should be equipped with by-product plants, it would, of course, said Mr. Fedden, be necessary to bear in mind that if such plants were installed for distilling the coal and making gas either for burning under the boilers or for driving a gas engine, the capital expenditure per kilowatt of plant installed would have to be considerably higher than it was at present in an ordinary coal-fired steam turbine station. In view of this larger capital expenditure, it would be necessary carefully to arrive at the percentage of the total plant, which could be economically operated by means of the fuel obtained by this by-product plant. In looking through his present load curves, Mr. Fedden had, he said, arrived at a figure of 2000 kilowatts of plant installed out of a total of 25,000 kilowatts. It would appear, therefore, other things being found satisfactory, that it might be economical to provide by-product plant for about 8 per cent. of the total plant of a power-house, and this plant should be run at practically 80 per cent. load factor to make it a paying undertaking. Of course, if such a thing as by-product plant were attached to a power station, a much larger area would be required, and this in many places would be difficult to find with the requisite facilities as regards water, coal, &c. Finally, the organisation of a boiler-house was dealt with in some detail.

## HULL JOINT DOCK.

### No. I.

WITH the object of bringing the dock accommodation of Hull up to the requirements of a port which lays claim to the third place in the United Kingdom, a large new dock has just been completed to the east of the present dock system by the enterprise of the North-Eastern and Hull and Barnsley railway companies, and will be formally opened by the King next Friday. It is the largest dock on the North-East Coast, and is capable of accommodating the largest vessels which use the northern ports. The following are the chief dimensions of the new dock:—Water area, 53 acres, provision for future extension to 85 acres; length of quays, 8162ft.; main basin, 1050ft. by 1000ft., enabling the largest vessels to manœuvre and leave bow foremost; entrance lock, 750ft. long by 85ft. wide; depth of water over sills, H.W.O.S.T., outer sill 42ft. 3½in., inner sill 39ft. 3½in.; depth of water in dock, H.W.O.S.T., 38ft., minimum 31ft. 8in.

The equipment, of the newest design and electrically worked throughout, includes the following:—Two graving docks, No. 2, 550ft. long by 72ft. wide, No. 1, 450ft. long by 66ft. wide, with provision for a third. Coaling appliances: Five electric belt conveyers, one fixed hoist, one movable hoist; total shipping capacity, 5000 tons per hour. The two hoists occupy one berth, and can feed the same ship, the movable hoist being adjustable to the hatches, and the six berths are so arranged in *echelon* that loading of six of the largest class of vessels can be carried on at the same time without diminishing the rate of shipment and without interfering with the independent movement of each vessel. When the equipment is complete there will be fifty-three cranes, ten of which are now in place, ranging in lifting capacity from 1½ tons to 80 tons, the latter being a floating crane which can be moved to any part of the dock. There are six warehouses built of ferro-concrete, with a total capacity of 73,000 tons of general goods, and a grain silo is about to be constructed which will have a capacity for 40,000 tons, and be fitted with eight underground belt conveyors capable of transporting from hold to store the output of four steamers at the same time, at a total rate of 960 tons per hour. Beside all this there is open storage space of 200 acres.

On pages 675 and 678 we give a number of illustrations of this great undertaking. Fig. 2, page 675, is a view of the site before the works commenced, the greater part of which is on the foreshore of the Humber and outside the old Humber protection bank, which roughly coincided with the new north quay wall. Before much actual progress could be made with the dock walls and general excavation, temporary reclamation banks had to be constructed. The first enclosed about 30 acres, and enabled a commencement to be made with the works at the north-east corner of the dock. A second bank was then proceeded with, enclosing a further 50 acres, which included the site of the lock pit and all the dock walls then contemplated. At the southern extremity of the second reclamation bank a timber dam was constructed across what was to be the outer end of the lock pit, and this shut out the tide water from the whole of the works. It was not removed until shortly after the water was admitted into the dock. A substantial embankment, formed of chalk rubble faced with sandstone pitching, has been constructed along the whole river front of the joint dock estate coincident with the Humber Conservancy line, and continued to a lower level for 382 yards still further eastward. The engineers experienced very serious trouble in the erection of these reclamation banks owing to the treacherous nature of the subsoil and the unsuitability of the material available on the site. The difficulties were overcome by using clay, which had to be brought from a distance. The area enclosed from the river was covered with a thick deposit of soft silt, locally known as Humber warp, and underlying this were various beds of boulder clay, running sand, peat and gravel—all of glacial origin. The lower beds of sand and gravel were heavily charged with water having a considerable head, and these conditions caused very serious difficulties in sinking for the foundations of the dock walls, and more especially the lock pit foundations.

As will be observed from the plan, the dock when ultimately completed will consist of a rectangular basin 1050ft. by 1000ft., out of which will lead four arms. Only two of these arms are at present constructed, viz., the north-west, 1350ft. by 312ft., which will be used for general commerce, and the north-east, 1356ft. by 450ft., which will be principally devoted to the shipment of coal and the importation of timber. Portions of the walls of the two additional arms where they lead out of the central basin are constructed, so that in the future these extensions can be carried out without any interference with the traffic. The water space now provided is 52½ acres, and when the future extensions are constructed the area will be increased to about 90 acres.

Access to the dock is given by an entrance lock 750ft. long and 85ft. in width, leading out of the south-west corner of the central basin and pointing upstream. This form of entrance was decided to be the most suitable, as the large vessels arriving at Hull come up the river on the flood tide, and after turning approach the dock entrance head to tide. The lock is divided into two pens by three pairs of gates, the inner pen being 250ft. and the outer pen 500ft. in length. The depth at high water spring tides on the outer and middle sills is 42½ft., and 39½ft. on the inner sill. Timber jetties are provided on each side of the entrance to the lock for vessels to lie against before being warped into the lock.

A fan-shaped channel has been dredged from the lock extending for about 320 yards into the river, measured from the general frontage line of the river embankment, and this will be maintained 1ft. below the outer sill, giving a depth of 21ft. at low water ordinary spring tides. The dock walls are constructed generally of 8 to 1 concrete, faced with fine concrete up to 13ft. below quay level. At this point a bevelled granite oversailing course is built into the concrete, and the wall above this level projects 12in., and is faced with blue Staffordshire bricks. The walls are coped with granite, and cast iron horn bollards are provided. Dock walls are constructed on three sides of the north-west arm, and on the south and west sides of the central basin, but owing to the unsatisfactory foundations, timber wharfing with a stone-faced slope behind was used along the south side of the north-east arm. The timber used is Tasmanian "blue gum."

The north sides of the central basin and the north-east arm will be used entirely for the shipment of coal, and here a series of concrete piers with stone-pitched slopes between have been constructed in such a way that ships can lie in *échelon*—as shown in

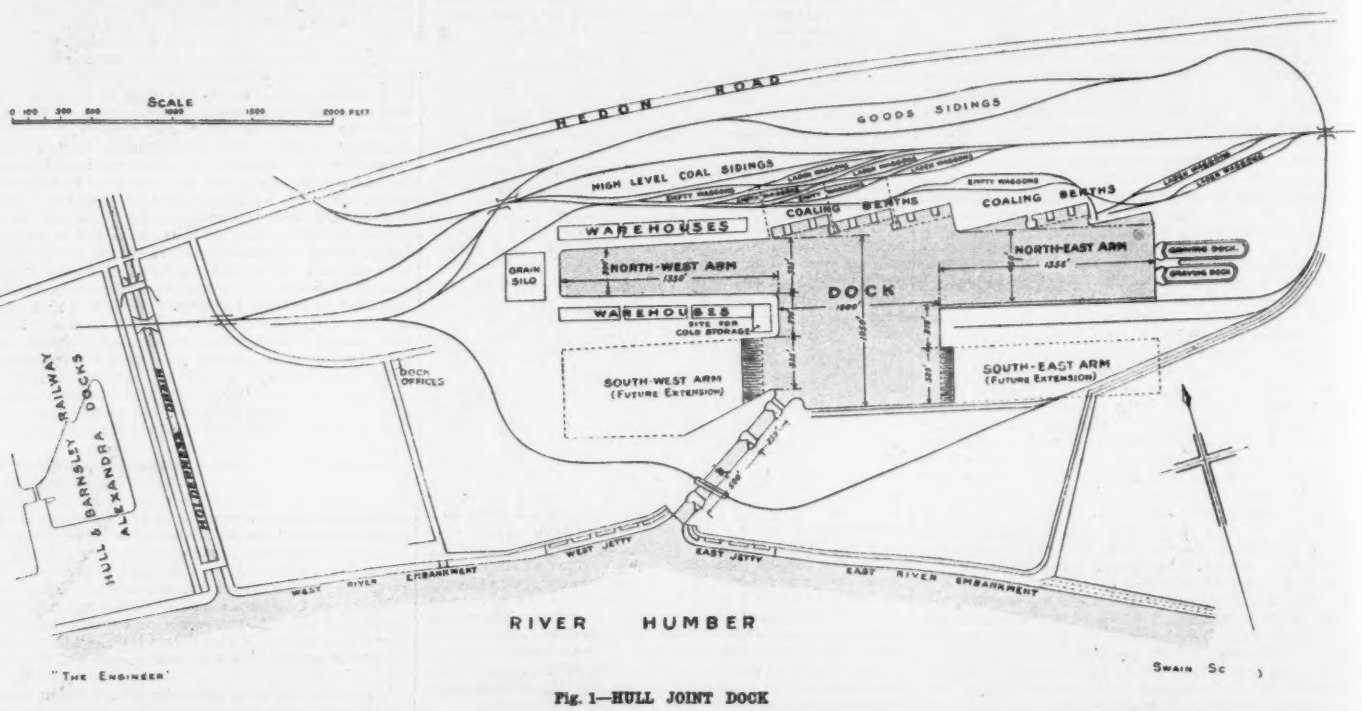


Fig. 1—HULL JOINT DOCK

# HULL JOINT DOCK

(*For description see page* 674)

Fig. 2—THE SITE OF THE DOCK BEFORE COMMENCEMENT OF WORKS

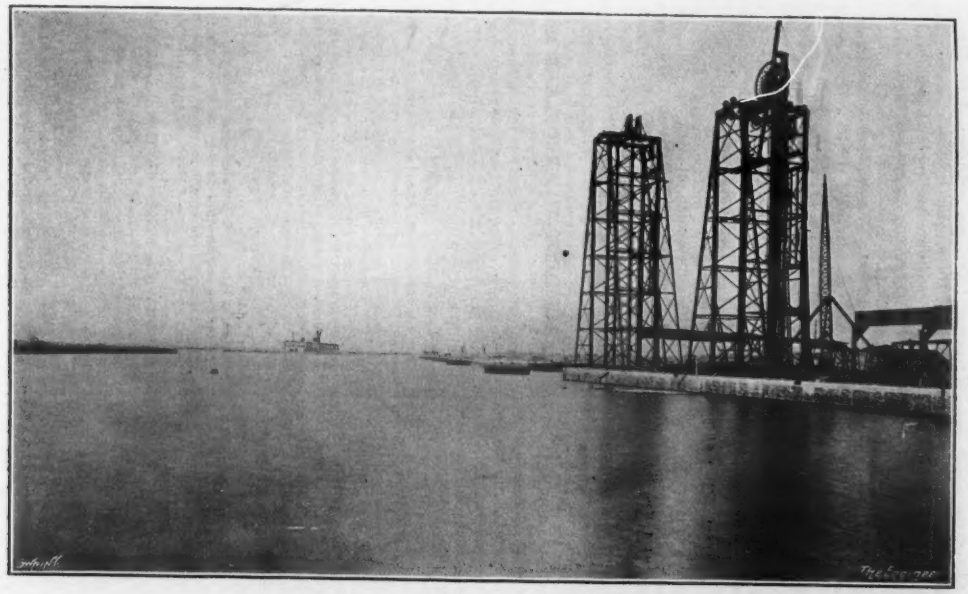

Fig. 3—END TO END VIEW, WITH COAL HOISTS IN FOREGROUND

Fig. 4—INTERIOR OF FERRO-CONCRETE WAREHOUSE

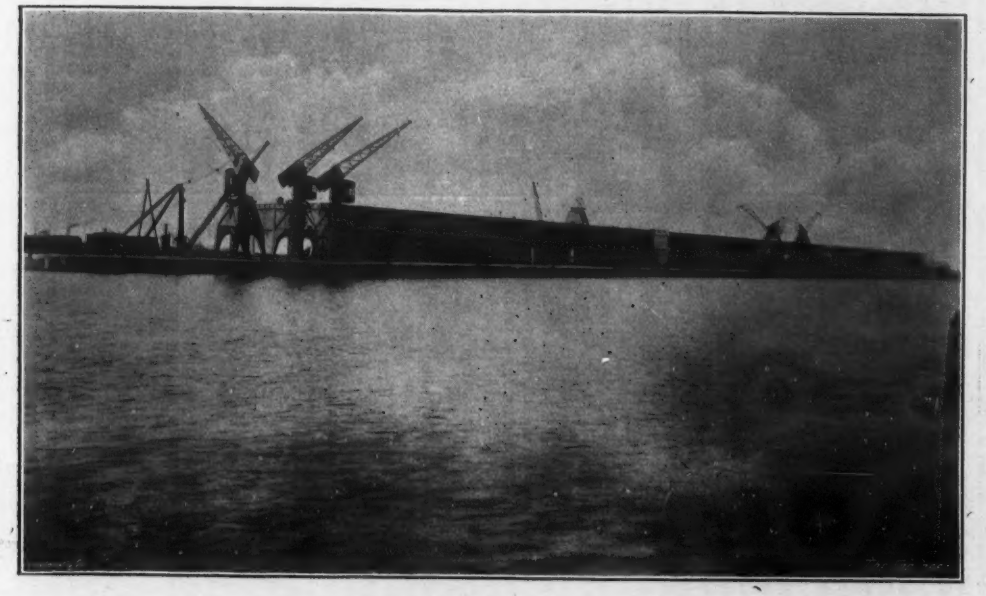

Fig. 5—FERRO-CONCRETE WAREHOUSES ON No. 3 QUAY

Fig. 6, page 678. Short timber jetties have also been provided to prevent vessels from touching the sloping walls, and suitable timber dolphins erected to separate the vessels where they overlap each other. At the eastern end of the north-east arm two graving docks —Fig. 7—have been constructed wholly of concrete, each having a minimum depth of water on the sill of 22ft. The dimensions are 550ft. by 72ft. and 450ft. by 66ft. respectively. The side walls of the lock are constructed of concrete faced with granite for 18ft. below the coping, and with blue brickwork below this level. The floor consists of a flat inverted arch of blue brickwork 3ft. in thickness, resting on a bed of concrete from 6ft. to 9ft. thick.

The construction of the lock was the subject of grave concern owing to the difficulties with the foundations. A suitable bed of hard boulder clay was reached at the required foundation level, but below this occurred a stratum of gravel and sand charged with water at a considerable pressure, and in such quantities that it would be impossible to reduce the head by pumping. It was evident that any attempt to excavate down to the clay level would be followed by the blowing up of the whole clay bed, and the possible destruction of the adjacent dam. It was therefore decided entirely to enclose the site of the lock by interlocked steel piling of heavy H section, which was driven from the dock bottom level to a depth of 45ft. This piling passed through the water-bearing stratum, and was driven well into a lower bed of clay, so that the surrounding water was entirely shut out. This method proved entirely successful, and although the construction of the lock was delayed for a considerable period, no further difficulties presented themselves, and when the steel piling was completed the work of building the lock walls and invert proceeded uninterruptedly.

The lock gates, which are of the semi-floating type, are constructed partly of iron and partly of steel, protected by substantial greenheart fenders. The outer and middle gates weigh about 370 tons per pair, and the inner about 352 tons per pair. There are no rollers or roller paths to these gates, and the unbalanced weight is taken by heavy anchorages at the top of the heel posts where roller bearings are provided to facilitate easy working. The system of operating these gates is new. At the back of each gate a long steel strut is fixed, the other end of which is connected to a sliding crosshead working in a tunnel built into the lock walls. Attached to this crosshead are wire ropes which are led over suitable pulleys and up vertical shafts to a hydraulic winch contained in a chamber just below the quay level. By operating this winch in either direction, a corresponding motion is given to the strut, which opens or closes the gates as desired.

Capacious ferro-concrete warehouses—Figs. 4 and 5 —have been constructed, occupying practically the whole length of the quays on each side of the north-west arm of the dock. Those on the north side are in three blocks, each 375ft. by 90ft., and are single-storey warehouses, and those on the south side are two-storey buildings, also built in three blocks, each 375ft. by 70ft. All these warehouses have flat asphalted roofs which can be used for storage of goods, and they are connected at the floor and roof levels by bridges; 1½-ton electric travelling cranes, built by Craven Brothers, are provided on the roofs of these warehouses, and by means of them goods can be lowered into railway wagons at the quay level.

At the western end of the north-west arm a ferro-concrete grain silo of 40,000 tons capacity is about to be constructed, and will consist of two large blocks, each containing 144 bins. A complete system of bank conveyors, elevators, automatic weighing machines, &c., will be installed, and ferro-concrete conveyor tunnels have already been constructed along the north and south quays. Portable elevators will be provided on these quays, and when the whole installation is completed it is claimed that it will be possible to discharge four grain ships simultaneously and also to deliver from the silo into lighter, for which purpose special conveyors and spouts will be provided at the west end of the arm.

A noteworthy feature of the dock is the complete absence of steam power. Electricity at 440 volts direct current, purchased from the Hull Corporation, will be used for all power purposes, and a system of electric cables has been laid round the estate for both power and illumination purposes. Where hydraulic pressure is required, as for the operation of the lock and graving dock, gates and hydraulic coal tips, the pumps are operated by electric motors.

The hydraulic plant has been supplied by Hathorn, Davey and Co., Limited, Leeds, and consists of three sets of horizontal electrically-driven three-throw pumps, each of which is capable of forcing 250 gallons per minute against an accumulator pressure of 850 lb. per square inch. The power water after being used for operating the dock gates, &c., is automatically returned to a tank above the pumps and used over again. The accumulators automatically start and stop the pumps when at the bottom and top of their stroke respectively. In order to relieve the shock at starting, Hathorn, Davey and Co. have patented an arrangement by which the electric motor is first set in motion by the accumulator, and the pumps are started against no load. When the electric motor has attained its speed the pumps gradually begin to pump, and when the accumulator begins to stop the pumps, the quantity of water delivered by them is gradually reduced to zero, and the motors are then stopped. It is claimed that this method is found, not only greatly to prolong the life of the plant, but also obviates any danger of an excessive flow of current in the motors at starting. Each of the pump rams is of hard manganese bronze, 5½in. in diameter by 18in. stroke, and runs at 55 revolutions per minute. The two accumulators in the pump-house are 16in. in diameter with a clear stroke of 18ft. A third accumulator, which is placed on the pipe system near the dock entrance, serves to regulate the flow of water at the end of the dock furthest from the pumps. This accumulator has a ram 18in. in diameter, and a stroke of 23ft. Each of the three return water tanks above the pumps has a capacity of 5200 gallons. In the event of this supply being interrupted through rupture of the main or other cause, an alternative supply is provided by means of electrically driven centrifugal pumps by W. H. Allen, Sons and Co., which draw water from the dock. Each of these three pumps is capable of raising 300 gallons per minute. The pumps are driven by Crompton's direct-current motors through double helical cut gearing and flexible couplings.

All the quay cranes travel on rails of 15ft. gauge, and have luffing jibs to give a horizontal movement to the load. Of this type there will be thirty, of 3 tons capacity, built by Royce Limited, Manchester, four 7-ton and nine 10-ton cranes by Craven Brothers, Limited, six of the latter being fitted with portable elevators for grain discharging. In addition to the above there will be a self-propelled floating crane of 80 tons capacity by Werf Gusto (A. F. Smulders).

The coal-shipping appliances—Fig. 2—by Head, Wrightson and Co., are situated on the north side of the dock, and berths will ultimately be provided for about seven vessels. At present two electrically driven belt conveyors are being erected, each capable of loading at the rate of 800 tons per hour, and two hydraulic coal tips, each of a capacity of 500 tons per hour. One of these coal tips is movable, and can be worked in conjunction with the fixed coal tip, so that when necessary both can be used for the loading of one vessel, or they can be used independently for loading ships of the usual collier class. Both conveyors and coal tips are constructed with a lift of sufficient height to enable the largest vessels to be loaded or bunkered. In connection with these coaling appliances a system of high and low-level sidings has been provided, which will enable advantage to be taken of gravitation working, and each conveyor or coal tip will have its separate set of sidings for loaded and empty wagons.

The 1½-ton cranes supplied by Craven Brothers, Limited, are placed on the tops of the warehouses. They have a maximum radius of 47ft. 10½in. and 57ft. 10½in. respectively. They are carried on tracks along the outer edge of the warehouse, the rails being 20ft. 7½in. apart. These cranes serve through hatchways in the warehouse roofs and over rails and roadways on the ground level outside. They have hoisting, slewing and derricking motions, each operated by its own electric motor. The speeds are as follows:—Hoisting full load, 250ft. per minute; derricking with full load, 200ft. per minute; slewing at maximum radius, 450ft. per minute; and travelling speed, 50ft. per minute. The cranes derrick into a minimum radius of 20ft. and 25ft. respectively, the motion being the speciality of the makers, by means of which the load is traversed in or out in a horizontal line while derricking. This feature is obtained solely by a beam pivoted at the jib head, carrying at the lower end the jib sheave, and at the upper end a radius rope anchored back to an A frame on the revolving superstructure, the sheave being constrained to move in a parabolic path having a certain relationship to the position of the barrel which makes the sum of the distance from the barrel to the sheave and from the sheave to the snatch block equal throughout the range of derricking. It should be noted that the rope leads off direct from the barrel over the jib sheave as in the ordinary derricking crane arrangement and the horizontal traverse is not obtained by distorting round any arrangement of sheaves. The crane consists of a plated gantry of the portal type mounted on four travelling wheels, and the revolving superstructure is carried on a pivoted centre post resting at the bottom in a compensating footstep bearing and guided by back and front rollers inside a vertical roller path at the top of the gantry, the roller path also forming a pin rack for the slewing motion.

With regard to the nine 10-ton cranes, these are fitted with the Musker-Davidson luffing gear, and are of the plated portal gantry type with a vertical revolving mast in accordance with the usual arrangement in connection with this luffing gear. Seven of the cranes are fitted with telescopic grain elevators which are carried by supplementary jibs at the back of the vertical post. When not in use the elevator jibs are derricked to the in position, raising the elevators and stowing them alongside the mast, and the crane is then ready for the ordinary work of cargo handling, and similarly when the elevators are put into action the main jib is derricked up to the in position. The elevators were manufactured by Messrs. H. Simon, Limited, and are each capable of discharging 120 tons of bulk grain per hour. They are driven by separate motors and discharge grain down shoots alongside the gantry into grain subways. The speeds of the movements of these cranes are as follows:—Hoisting, 10 tons at 50ft. per minute, 3 tons at 150ft. per minute; derricking speed with full load, 100ft. per minute; slewing speed with hook at maximum radius with full load, 300ft. per minute; travelling speed without load, 30ft. per minute.

The whole of the work has been carried out under the direct supervision of the engineers of the two railway companies, viz., Mr. T. M. Newell and Mr. R. Pawley, who were appointed joint engineers by the Hull Joint Dock Committee. Mr. W. Ebdon has acted as resident engineer, and Mr. T. L. Norfolk has superintended the construction of the equipment. The new dock offices and other buildings of an architectural character have been designed and erected under the supervision of Mr. W. Bell, the architect to the North-Eastern Railway. The general contractors for the dock are Messrs. S. Pearson and Son, Limited, of Westminster.

## ACCIDENT TO AEROPLANE No. 204.

The Advisory Committee for Aeronautics has had under consideration the cause of fracture of the rudder post of aeroplane No. 204, which caused the collapse of the machine which caused the death of two officers at Netheravon on March 11th. It reports that:—

The fractured post has been carefully examined at the National Physical Laboratory, and the material of the post has been submitted to mechanical tests and to microscopic examination. The Committee have instructed me to reply as follows on the specific points referred to in your letter:—

1. *Sufficiency of the Original Strength of the Tube as Designed.*—The maximum stress on the rudder post under the most severe conditions which, in the opinion of the Committee, could occur during flight, has been estimated, and the unwelded tube was found to be capable of bearing not less than three times this stress. The maximum stress thus estimated only falls on the rudder under exceptional conditions, and this figure implies, therefore, a much higher value than 3 for the factor of safety, as the term is at present ordinarily used in aeronautics.

The Committee are of opinion that the tube, unless it were damaged by the method of attaching it to the rudder, was sufficiently strong.

2. *The Effect of Filing.*—The Committee are of opinion that the effect of filing was negligible.

3. *Effect of Welding.*—The evidence afforded by the report showed that the tensile strength of the tube was considerably reduced by the welding process, but this reduction alone was insufficient to account for the accident. It is well known, however, that heating steel, even for a short time, to the temperature required for autogenous welding, in addition to seriously diminishing its strength and ductility, also reduces its power to resist alternating stress or shock.

4. *Effect of Possible Bending and Straightening, or Vibration.*—Examination of the sound portions of the tube did not furnish evidence of an effect due to possible bending and straightening. Such effect would, however, be most likely to occur at the weakest part of the tube, and might be masked by the fracture. There was some slight corrugation on the compression side of the tube which might have existed prior to the fracture, indicating that bending had taken place or might have been caused at the time of the accident.

Vibration of the rudder, if set up by some cause producing impulses synchronous with the natural oscillations of the rudder, might give rise to stresses of considerable magnitude. No evidence was before the Committee that this had occurred, but the necessary conditions might arise if the engine were run while the machine was on the ground.

5. *Effect of Absence of Wood Filling.*—The margin of safety referred to under (1) was calculated on the strength of the tube alone, without wood filling. The factor of safety would not be raised to any considerable extent by the presence of the wood filling.

*General Conclusions.*—So far as it is possible to judge from the available evidence, the stresses to which the rudder post was subject at the time of the accident were well within the margin of safety of the design, and the Committee are forced to the opinion that some flaw existed before the machine left the ground. It does not follow, however, that such flaw could have been detected by external examination.

The fracture took place across a section where the bending stresses were not far from a maximum, and where, owing to the fact that the steel had been raised to the temperature required for autogenous welding, and thus "overheated," the tube was weakest. The machine during its life, though not at the time of the accident, had been subject to severe stresses, and it is possible that the action of these had been sufficient to set up a flaw in the region of the tube, which had been "overheated" by the welding, and that this flaw had gradually developed so as to lead to the breakdown. Or again, it is possible that the rudder post had been slightly bent by accident or by rough usage, and that the flaw had been started thus, or as a result of subsequent straightening; though, from experiments which have been conducted, it seems unlikely that the flaw can have originated in this manner. If, however, this were the case, the bending must, as would be expected, have been confined to the neighbourhood of the fracture where the tube was weakened by the welding. The microscopic examination did not show signs of such ill-treatment, but near the fracture these may have been masked by the break itself.

There is no reason to suppose that the slight filing noted, or the absence of the wood filling, contributed to any appreciable extent to the disaster, while, apart from its condition at the weld, the material of the post was good and amply strong enough for the stresses it had to bear in use.

We learn from the *Manchester Guardian* that a gift of £10,000 from an anonymous donor has been offered the Royal Technical College of Glasgow in aid of research work. The donor believes that lack of funds prevents the College from properly developing the work of research which is its peculiar province. With evening classes as well as day classes to attend, the present teaching staff, he recognises, is unable to devote either the time or the energy to research which it is d sirable that the Coll ge should undertake. As an example of what is required, he cites the need for the tests on materials used by lo al firms. He accordingly will give the £10,000 to the general endowment of the College, provided that other additions amounting to not less than £15,000 are promised within one year, the accruing income to be devoted o research. The Governors of the College have appointe l a Committee to endeavour to meet the conditions laid down in the gift.

## RAILWAY MATTERS.

ON Wednesday morning last a collision occurred at the east end of the Great Western station at Reading, between an express and an excursion train. The driver of the express was killed.

THE accounts of the Lorain surface contact system at Wolverhampton for last year show that the working costs per car mile have, as a matter of fact, increased to 6·651d., as against 6·272d. in the previous year. The increase, however, is, in a large measure, due to an alteration in the assessment of the undertaking from £2500 to £5294. The financial result is a net profit of £5553.

A COMMITTEE of the Town Council of Berlin is now investigating a project for the construction of a tunnel for the use of street cars under the city's most fashionable street, Unter den Linden. The carrying out of the project, if it is approved, will relieve a growing congestion, and greatly improve the appearance of the important thoroughfare, by permitting the removal of the street cars from it. The tunnel would have parallel eastern and western sections, and one northern entrance for four lines and two southern entrances for two lines each.

A DECISION to weld the rail joints on the San Francisco-Oakland Terminal Railways by the electrical process was made when Mr. A. W. McLimot became general manager of that company, and the work has now been completed. A record was made, it is thought, in assembling equipment on the job from an eastern point. The welding outfit worked on the line of the Grand Rapids, Mich., Railroad on April 22nd, and was then shipped to Oakland, Cal., on three gondolas in time to be at work again on May 6th, thus losing less than two weeks between jobs 2500 miles apart. The process used is that of the Lorain Steel Company.

STATISTICS issued for 1913 show that in Austria, Bosnia, and Herzegovina there is a total of seventy-three direct-current railway systems, of which twenty-five operate at 750 volts or more, and six single-phase systems. Twenty-four of the railways are operated on standard gauge and fifty-five on narrow gauge. The length of the direct-current lines is about 723 miles, and of the alternating-current lines about 150 miles, or 873 miles in all. During the year the increase in the number of direct-current lines was twelve and single-phase lines three. The increase in the length of direct-current lines was 92 miles, and single-phase lines 106 miles.

ALTHOUGH the Central London is a comparatively new railway, having been opened only fourteen years, its value has, of late years, been handicapped by the fact that it was controlled by signals operated mechanically from signal-boxes. The utility of the line was, therefore, governed by the number of boxes, and this, owing to the impracticability of fixing boxes elsewhere than at the stations, was exceedingly limited and in distinct contrast to the facilities afforded on the other tube railways, except the City and South London. In the *Railway Gazette* of June 12th is a description of the work just completed, whereby the Central London has been converted to an automatically signalled line, which will enable a greater service of trains to be provided when such is considered necessary. The number of block sections has not, as yet, been materially increased, but the great advantage an automatic system has over a mechanical is that the number, as the demands of the traffic increase, can be added to readily and without much alteration or expense. The type of signal almost universally employed on the Central London is most interesting; there are no moving parts, only electric lights behind, red—or yellow—and green lenses, and the current for illuminating the red glass is always present, so that in case of failure the red is bound to be shown.

GREECE, states the *Railway News*, is the only European country which has not hitherto been connected with the Continent by a railway, and the advantages of linking up the Piræus line with the European system are perfectly obvious to everyone. When this is done, Greece will be placed in direct daily communication with the rest of Europe, and Athens will be only sixty hours from Paris and seventy-one from London. The junction of the Greek railways would be a matter of great international importance, as mails and passengers to India would save at least thirty hours on each journey, the route from the Piræus to Port Said being 324 miles shorter than that from Brindisi. In the course of a Foreign-office report on the subject, it is pointed out that this outcome will be attained by the building of a new line linking the Greek Athens–Larissa Railway with the Oriental railways, for which the Greek Government has contracted with a French firm. The line will be about 59 miles long, and will have a normal gauge. The surveys and plans are complete and approved by the Committee of Engineers for Public Works in Greece, and the cost of construction is estimated at about £300,000, which, with rolling stock, &c., may reach about £360,000. The time for completing the line is eighteen months, with a substantial bonus if finished sooner.

AT the main shops of the Illinois Traction System in Decatur, where all of the inter-urban equipment for the 450 miles of line in central Illinois is repaired, a simple little air brush is used for applying varnish to the inside of motor cases. It is connected with the shop air supply system by a hose. The spraying part or atomiser is so arranged that there is no pressure on the can which holds the varnish. When using this brush the interior of a motor case with coils in place can be thoroughly covered with black air-drying varnish in five minutes. Probably the greatest advantage of the air brush method of covering the interior of motor cases is the assurance of obtaining thorough results. With the hand method of painting, even though the motor cases may have been cleaned with the utmost care, nevertheless considerable carbon dust and copper dust will remain lodged in the corners. If varnish is applied by hand this dust, which is a good conductor, gets mixed into the varnish, and it is very difficult to coat the motor casing in such a way that the varnish will have any great value as an insulating medium. There are bound to be places where the carbon and copper will stick through the varnish. The air brush sprays the varnish finely but with considerable force, and thus the copper and carbon dust are packed against the steel and thoroughly covered.

## NOTES AND MEMORANDA.

FOR milling flat aluminium surfaces it is stated in the *Brass World* that it is best to use end mills rather than cylindrical cutters. These mills will cut best if a high cutting speed is used with a moderate feed. The depth and width of the cut is of less importance. A cutting speed of 325ft. per minute can be considered as practical and from 2 to 4 cubic inches of metal can be removed per minute in aluminium.

WHAT is claimed to be the largest compressor so far adopted in connection with the coal-mining industry of Germany has been completed by the Frankfurter Maschinenbau Gesellschaft (Pokorny and Wittekind), of Frankfort-am-Main, for the Werne Collieries of the Georgs Marienhütte Gesellschaft. The machine, which runs at a speed of 82 revolutions per minute, is capable of compressing 635,580 cubic feet of air per hour to a pressure of eight atmospheres.

THE author of an article in an American contemporary suggests that the contact wire used on electric traction systems should be rolled in such a way that a flat surface comes in contact with the collector. With a round contact surface for some considerable time the collectors are rolling on a very small surface of the wire; as the pressure is great, the wear on the collectors is very rapid. This wear takes place with a new equipment, and could be altogether avoided if the wire had a flat surface to start with.

A DEMONSTRATION of the possibility of steam raising by the combustion of liquid fuel directly in contact with water has been made in Bremen, Germany. An apparatus consisting of a cylindrical boiler, provided with a number of pockets isolated and drained by suitable valves and drain cocks, was used. Each of these pockets contains an oil burner, with a pilot burner, by means of which the main burner can at starting be sufficiently heated to effect complete combustion of the oil. When the main burners are well alight, water from the boiler is permitted to flow into the previously drained pockets, and the circulation of heated water commences, the products of combustion as well as the steam generated being used as a source of power in a steam engine.

ACCORDING to a recent patent for lubricating wire during drawing, lubricating material combined with organic binding material is applied to the wire, and the binding material is carbonised to cause the lubricant to adhere to the wire. A suitable lubricant is made by incorporating glucose or cane sugar with graphite stirred up in water; one pint of the material known under the trade mark "Aquadag" is mixed with 2½ pints of water, and adding about 70 c.c. of the glucose solution sold as "Karo Korn syrup" or cane sugar boiled down to molasses. Suitable preservative, such as a solution of bichloride of mercury, may be added. The preparation may be applied by drawing the wire through a vessel or cotton waste containing it, or by passing it over a grooved pulley running in the liquid.

IT is reported from the University of Göttingen that Drs. Leimbach and Löwy have perfected a device for detecting subterranean springs and ore deposits by means of "wireless" waves, thus obviating the necessity for boring operations. The device has proved successful in practice in the province of Hanover. An expedition under the auspices of the German Colonial-office is now at work detecting water supplies and ore deposits in South-West Africa. A second expedition will be fitted out for experiments in the United States as soon as possible. The new appliance has already been found useful in determining with certainty the danger of floods in salt mines. In mines in watery strata, where freezing or cementing systems of shaft sinking are employed, the electric waves effectively revealed flaws in the protective walls.

AN effort to secure the proper goggle for workmen subject to the intense glare of incandescent metals has been undertaken by the F. W. King Optical Company, Cleveland, Ohio. It has been found that the smoked and blue glasses commonly used defeat their very purpose of minimising eye strain. Two kinds of light rays are regarded as particularly injurious to the eyes, the chemical or ultra violet and violet rays, which have a deteriorating action on the tissues, and the heat or red rays which by their intense energy are probably the chief cause of eye fatigue. Smoked or blue glasses offer no resistance to the former, it is claimed, and are therefore of no benefit except to exclude much of the glare; while red, orange and similar glasses transmit the very harmful heat rays. In order to make the ideal goggle, it is held to be necessary first to cut off the invisible violet rays and then reduce the visible spectrum so as to absorb heat or energy rays to a point that produces no eye strain whatever. Of all the colours, a yellow-green seems best to accomplish this. It not only reduces the light to the limits desired, but it also distorts images less than any other. Moreover, the variation of brightness of incandescent metals with temperature appears relatively the same through this kind of glass as through uncoloured glass.

THE University of Wisconsin has issued a bulletin relating to a series of investigations to determine the temperature limits between which tars are distilled from various classes of American coal. The conclusions arrived at are as follows:—(1) Tars first commence to distil from any grade of bituminous or lignite coal at about 300 deg. Cent. (2) The greatest quantity of tar is distilled between the temperatures of 375 deg. Cent. as an average lower limit and about 475 deg. Cent. as the final temperature. (3) The tars are all evolved on the average when the coal reaches a temperature of 550 deg. Cent., though in some cases tar does not cease to appear till the temperature reaches 600 deg. Cent. (4) There is evidently a distinct relation between the amount of tar distilled and the geological formation of the coal, or, more particularly, the carbon-hydrogen ratio of the coal. The maximum amounts of thick tars can be expected from coals with carbon-hydrogen ratios ranging from about 13.5 to 18. It is also possible, knowing the carbon-hydrogen ratio of any given coal, to predict with considerable accuracy the probable amount of tar that will be distilled as compared with some other known coal.

## MISCELLANEA.

IT is officially announced that from and after January 1st, 1915, the maximum draught of water allowed to ships going through the Suez Canal, which is at present 29ft., will be increased to 30ft.

IT is reported that the Canadian Government intends to invite tenders for a dry dock at Esquimalt capable of accommodating the largest ships in the navy. The cost is estimated at between £300,000 and £400,000.

EXPERIMENTS with aeroplanes and grenades have been carried out by the Royal Flying Corps at Aldershot, in the vicinity of Jubilee Hill, Long Valley. The grenades were fastened to steel rods, which were inserted in the barrel of an ordinary rifle, and fired by the rifleman with the gun at his shoulder.

ON Wednesday, 17th inst., the German Emperor opened a ship canal, the Hohenzollern, which, leaving the river Oder at Hohensaaten, near its mouth, runs to Berlin, and enables ships of 600 tons burden to circulate between the capital and Stettin. The canal is about 60 miles long, and has cost about two and a-half million pounds to construct.

THE most biting observation which has ever been made about airships may be found in the brief report by a *Times* Berlin correspondent on the loss of the German Zeppelin Z 1. The correspondent writes:—"Airship wrecks are now regarded very placidly here, and do not even occupy any large space in the Press." The vessel was wrecked whilst trying to land at Diedenhofen, near the French frontier. She was forced to descend owing to exhaustion of her gas and increase of weight due to a rain storm. She had been in commission only one year and was, we understand, the fourth vessel to bear the same title.

THE first number of the *Journal* of the Institution of Mechanical Engineers has appeared. The first part of it, after an introduction, is given up to the forthcoming meeting at Paris and other Institution notices. A good feature is the publication of abstracts of the papers to be read in Paris. The second part deals with the meeting on April 24th last. It includes the whole of Mr. Rothera's paper on "The Electrical Driving of Existing Rolling Mills" and a report of the discussion. We learn from the introduction that after the current year Part II. will be presented on thick paper, suitable for binding, and will take the place of the present "Proceedings."

AN instructive accident occurred off the American coast on Saturday last. The liner New York was, when hove to in a fog, struck by the Hamburg–Amerika liner Pretoria, and a hole, reported to be 32ft. long and about 12ft. wide, was ripped in her port side. Luckily it was above the water-line, and the accident therefore led to no disaster. The resemblance to the Empress of Ireland collision cannot escape the reader. The conditions were almost the same, save that the attacking vessel was smaller and that the ill-fated steamer was ripped below instead of above the water-line. The accident is instructive as showing the nature of damage done by a glancing blow, and strongly supports the advocates of the double-skin ship.

PROPOSALS for a daily budget of news to keep the passengers on steamers fitted with wireless telegraphy abreast of happenings inside and outside the Commonwealth is embodied in a scheme which the Postmaster-General has submitted to the shipping companies trading in Australian waters. Mr. Agar Wynne states that the proposal is a *précis* of about 400 words, covering the news of the day, should be sent to all passenger steamers through the Australian wireless stations. The scheme can be applied to the mail steamers, which will be placed in possession of Australian and other news when they are 2000 miles from the land. Discussing other features of the Australian wireless system, Mr. Wynne says that he was considering the question of reducing the rates to make the service more popular.

IT is said that during an attack made by the Mexican Constitutionalists upon the Federal forces in the city of Matamoras, Mexico—which is just opposite Brownsville, Tex.—the defending Federal troops entrenched themselves behind a barricade of barbed wire, and then, as an after-thought, their commander hit upon the pleasant scheme of connecting this barbed wire to the lines of the Matamoras electric plant, so that a deadly shock would be given persons making contact with it. During a fierce assault on the Federal works six or seven Constitutionalist soldiers were electrocuted by the wire before the deadly nature of the barricade became known. Withdrawing his infantry for the time being, the rebel general then directed his field guns upon the electric plant, with the result of quickly shutting it down. Returning to the assault the now innocuous barbed wire entanglement proved only a slight obstacle to the final capture of the city by the Constitutionalist forces.

SIR CECIL HERTSLET, the British Consul-General at Antwerp, in his report for the past year, points out that all the shipbuilding yards at that port were fully occupied and a record tonnage was turned out, amounting to 30,137 tons gross, including a number of tugs, lighters and small craft measuring 12,835 tons. The total tonnage launched during 1913 shows an increase of 11,350 tons over that of 1912. The prospects for 1914 are good in the Belgian building yards. It is curious, he adds, that at the time the British Press referred to an order passed to shipbuilders at Dunkirk for British vessels, no mention was made of the fact that a number of steamships has been constructed at Antwerp for British owners. In 1912 two vessels of over 1200 tons each were launched at Antwerp for the British flag. During 1913 three steamships, measuring respectively 1276, 1950 and 4026 tons gross, were launched at Antwerp for British owners. Since the year—1913—to which these figures refer, viz., in February, 1914, a large British vessel, the Lowther Castle, of 4333 tons gross, has been launched from the yards of the Antwerp Engineering Company at Hoboken, and is the largest British vessel that has ever been built in Belgium. The fact is noteworthy as showing the progress which is being made in ship construction at Antwerp.

# HULL JOINT DOCK

(*For description see page 674*)

Fig. 6—COALING BERTHS, SHOWING ECHELON ARRANGEMENT

Fig. 7—GRAVING DOCKS WITH OIL JETTY IN DISTANCE

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*** *With this week's number is issued, as a Supplement, a Two-page Drawing of a 40-Ton Steam Titan Crane. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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### INQUIRIES.

TOFAM FILTER.

SIR,—I should be much obliged if any of your readers would give me the names and addresses of the manufacturers of the Tofam filter, or any other tap filter of similar make.

R. S.
June 17th.

# THE ENGINEER.

*JUNE* 19, 1914.

### Industrial Unrest.

WE do not suppose that many employers of labour, or many officials of trade unions, will devote more than passing attention to the report of the Unionist Social Reform Committee on Industrial Unrest. It will be read, no doubt, by Unionist parochial politicians, and pebbles picked from it will be hurled at Liberals in suburban "Parliaments." But that it will affect in any measurable degree the great industries of the country we do not believe. Having no political ties, we are more at liberty to speak the truth about it than the daily papers, which must either support it or vilify it to satisfy the political bias of their clients, and we say, after reading it with care from cover to cover, that we are wholly unable to see what good end it can serve. The Committee, indeed, has no new solution of a very vexed problem to offer. It desires to see minimum wages established in the country's industries, and it proposes the adoption of a "board" composed of a representative of the employers, a representative of the men, and an independent chairman, which should arbitrate on matters in dispute. But the findings would not in any cases be binding on either party unless there were a substantial majority of that party in their favour, and the only means of enforcing them would be to put recalcitrant workpeople outside the pale of the minimum wage regulations. What is to be done with the rebellious employer the Committee does not tell us, save that when the point at issue is connected with the minimum wage, it is to be in the power of the Factory Inspector —of all people in the world!—to collect the difference from the employer. We hesitate to give the proper adjective to a scheme so futile and so dangerous.

The Committee indeed has started from a wrong basis. Its plan is to be founded on State meddling. "It is," it says, "incontestably the right and duty of statesmanship to supervise and control the conditions of employment of the State as a whole." Far from being incontestable, such a right on the part of a State is contestable in the highest degree. The State might as well claim the right to interfere between the buyer and seller of a horse. The proper attitude of the State, we hold, is not to interfere in any way with lawful and peaceable bargaining. If the bargainers come to blows, the State may separate them in support of the public weal, but it absolutely has no "incontestable" right to say for how much a commodity should be sold and for how much it should be bought. The Committee's views are radical and socialistic, not conservative at all. "We consider it necessary that employers should frankly abandon the principle of buying labour in the cheapest market, in the supposed interest of the consumer or of the taxpayer, without regard to that of the producer." We are at a loss to understand what the latter part of this sentence means, but with regard to the first and lucid clause we say point blank that such an unconditional statement is absurd. Is the Committee of opinion that for work on which cheap labour—boy or girl labour—can be employed, full skilled rates should be paid? It appears to be ignorant of the fact that there are grades of labour, and that whereas it is profitable to employ the highest class labour at the highest wages on certain work, it would be not only wholly unprofitable, but wholly disastrous, to employ such labour on other classes of work. The minimum wage, then, must either be graduated or must be so low that it is already more than covered by the rates employers are now willing to pay. Graduation beyond a certain point is impossible without imposing restrictions which are injurious to trade as a whole. On what basis is the minimum to be fixed? On day work, then the employer is justified in driving every man to the ultimate output for the least wage; on piecework, then we have to face the union restrictions which strive to bring remunera tion and diligence back to one level again. Minimum wages have been established in many industries, but, with few exceptions, always by voluntary action between employer and employed; the arrangement is of the nature of a bargain, and the conditions of employment are of a kind that lend themselves to it. The compulsory establishment of minimum wages by the State always leads to trouble—it is sufficient to quote the Coal Mines Minimum Wages Act. Where we are dealing with a commodity like labour, which is extremely variable in its value, the more freedom for bargaining there is the better for both parties. The man that is worth only a sovereign a week can earn a sovereign, whereas if the employer must pay thirty shillings he employs a man that is worth that wage, and the sovereign man must remain idle and a burden to his fellows and the community. The Committee has obviously wholly misunderstood the problem. It writes, "few economists now believe that bad wages spell good work or cheap and efficient production." We should be interested to meet the practical economist, the manufacturer, who ever held that bad wages spelt good work. The thing is ridiculous. What the economist does say is, given the production of a certain standard of work, he must keep his wages cost on it as low as he can. That is a very different thing. He may, for example, by adopting automatic machinery be able to employ one man at high wages to do what half a dozen did before, and so reduce his labour costs. On the other hand, he may, equally by the adoption of automatic machinery, be able to replace one highly paid workman by half a dozen boys and girls at small wages, and yet so increase his output, always keeping to the given standard of excellence, that his labour cost per piece is lowered. The quality of the work is quite independent of the wages paid. It is fixed at a certain standard, high or low as the case may be, and is uninfluenced by the rate of wages. May we, we ask, reverse the dictum of this economist and say high wages spell bad work? Then clearly the lower the wages we pay the better the product! The whole thing is absurd. The Committee goes on to say, "cheap labour is no longer regarded as an essential to cheap production." Here, again, there is a grave fallacy. "Cheap" is a comparative term, not a positive one. Belgian rails are sold in this country cheaper than British rails. The quality is the same, the method of manufacture the same, the ratio of profits the same, but the labour costs are lower. If you lower the labour costs, you lower the profitable selling price. You may reach the same end by reducing other costs than labour costs, but you do not thereby alter the fact that if you still further cheapen the labour you still further cheapen the product. A few years ago twenty pounds sterling or more had to be paid for a bicycle, now one may be bought of equal excellence for a quarter the sum. Why? Because in a large degree the labour costs as a whole have been reduced. On some work they have been raised, on other work lowered. No such generalisation as the words of the Committee convey is admissible. But leaving these false views to one side, let us see what the practical propositions of the Committee amount to. We quote from the conclusion to the report: "The function of the State as here conceived is to provide machinery for setting up Conciliation and Wages Boards where such Boards do not already exist, and to encourage those industries which already possess a rough system of conciliation and wages agreements to extend and make more effective a method which they already pursue. The instrument to be used for this purpose is that of the recognition of agreements, by which the party which breaks a recognised agreement loses the advantage of the certainty of an agreed wage sanctioned by the Chief Industrial Commissioner." There we have, as already foreshadowed, the sum and substance of the scheme. Put briefly, they amount to this. The rates of wages shall be settled by a Government official; if, being a workman, you do not agree to them they shall not bind you! If you, being an employer, refuse to pay them when the men have accepted them, the Factory Inspector takes the difference from you—by a method not specified; if you, being a workman, refuse when the master accepts, he can only invoke public opinion to bring you to a wiser frame of mind! The Board may, we are not quite clear on the point, sanction the reduction of the wages of such men as remain in employment, if more than one-third of the whole number in the trade in the district refuses to accept the award. The effect would be to drive those that were willing to work into the ranks of the strikers.

In any case, labour may bite its thumb at the employer; he cannot touch it.

Strongly as we are opposed to compulsory arbitration, we say that we would prefer to see Acts like those of Canada and Australia on the statute-book, than to see such milk-and-water compulsion as this introduced. On some points the Committee is sound, but they are old and familiar points. Arbitration, we know, will do good by delaying an outbreak, and many a strike has been averted by methods of conciliation. But there is already more than enough machinery in existence for these purposes. Where they have failed, any other body of a similar kind would fail; the degree of compulsion that is to be derived from the "recognition" of a minimum wage is not worth considering. The Committee does, however, make one really good suggestion, and we give it every credit for it. It strongly advocates a wide publicity of the matters in dispute. This is an excellent proposal, and we are convinced that it would do much good. The Press does its best at the present time, but it is rarely able to put an absolutely impartial and full statement of the case before the public, and if a competent person could be found to write day by day and circulate a full and true account of the day's proceedings, during and before arbitration, a great service would be done. If, moreover, the State could ensure that all ballots of men or employers were open, and that the questions submitted to possible strikers were not of a leading or of an equivocal nature, more still would be done to bring disputes to a peaceful issue.

### Russian Naval Expansion.

THE reports which have recently been in circulation in European newspapers concerning further prospective developments in naval shipbuilding schemes in Russia have now been confirmed by the definite announcement that the Duma has just voted an expenditure of £10,000,000 for the construction of warships for the Black Sea fleet, and by the intimation that a second extraordinary shipbuilding programme will be brought forward in the autumn involving an expenditure of the considerable sum of £60,000,000. As the former proposal has been approved by the legislative assembly, it is highly probable that the latter scheme will also be sanctioned by the Duma, although it has to be remembered that, as has happened on former occasions, the Government or the Imperial Council may override any adverse vote given by the Duma. On paper, the naval expenditure incurred by Russia is constantly increasing. In 1910–11 the Duma approved an outlay of £9,880,000 for the development of the navy, and the amount was advanced to £11,885,000 in 1911–12, £17,745,000 in 1912–13, and £24,880,000 in 1913–14, whilst the sum of £27,400,000 has been provided for the current financial year. To the latter has now to be added the extraordinary vote of £10,000,000 for the Black Sea fleet and the prospective scheme for the appropriation of a further sum of £60,000,000, although in both cases the amount will be distributed over several years. The annual sums in question evidently relate to the total expenditure on the navy, as the outlay voted for new construction alone is given in the latest English return at £3,216,000 for 1911–12, £6,897,000 for 1912–13, and £11,844,000 for 1913–14. The secrecy which is manifested in Russia with respect to naval expenditure and the situation of the shipbuilding industry, however, renders it difficult to ascertain the actual position of affairs, especially as various shipbuilding schemes have been brought forward in recent years. From the standpoint of the numerical possession of battleships, Russia occupied the third position among the leading Powers at the beginning of the war with Japan, Great Britain being first and France second at that time. But the results of the war left Russia in an unfortunate position, and many years will still have to elapse before it will be possible to reconstruct the Baltic fleet, apart from the extensions which are in progress or contemplation in the Black Sea.

It may be of interest to refer to the course of affairs since that period. In 1907 the Russian Admiralty sought the approval of the Duma to expenditure for the construction of a battleship division composed of four units. After being refused, the Imperial Council sanctioned the scheme against the wish of the Duma and the work of building was begun in the middle of 1909. The ships on completion, which is said to be expected this year, will be the first modern Dreadnoughts in that country; they are of the "Gangut" class and are believed to be equipped with twelve 12in. guns. As it was desired to have a definite shipbuilding programme a comprehensive scheme was prepared, having the year 1909 as the starting point and 1930 as the concluding year. The scheme aimed at the provision of a new fleet for the Baltic composed of 24 battleships, 12 armoured cruisers, 24 protected cruisers, 108 torpedo-boat destroyers, and 36 submarines. It was, however, rejected as a whole by the Imperial Council, but a first instalment of four battleships was approved by the Duma in 1912. This division is the largest class of ships—"Borodino"—in course of construction; the displacement is 32,500 tons, the main armament is said to be twelve 14½in. guns, and the vessels are to be completed in 1916. If this expectation is fulfilled the Baltic fleet in that year will consist of four old battleships arising from the Budget years of 1898, 1901, and 1903, six armoured cruisers having no modern armament, the four battleships of the "Gangut" class, and the four super-Dreadnoughts of the "Borodino" class, together with auxiliary ships. The last-mentioned will therefore form the first instalment of the comprehensive scheme which was brought forward in 1909, and the second instalment is to be submitted in the course of the present year. Whether this will be the case remains to be seen, as it is possible that the foreshadowed project for an extraordinary expenditure of £60,000,000 may be in substitution for the second instalment in question. At any rate, the present is not the first dissemination of a report to this effect, as it was stated as far back as last October that the Ministry for the Navy, in order not to allow the shipyards to be idle on the completion of the "little naval programme," had devised a scheme for the construction of two squadrons of eight battleships each, four armoured cruisers, eight lighter cruisers, thirty-six destroyers, and twelve submarines, all of which are to be finished by 1930. This report, which apparently emanated from official circles, was accompanied by the statement that the Minister for the Navy estimated that a portion of the contracts would have to be placed abroad in consequence of the inability of the Russian Government and private yards to carry out the whole of the work in the period of years in question.

The time occupied on the construction of warships in the Russian Government dockyards in the Baltic and at Nikolaieff, in the Black Sea, has hitherto been exceptionally long, whilst the capacity of the private yards is being developed with the aid of British firms, and is expected to accelerate considerably the rate of building and enable these yards also to turn out the largest types of battleships. A period of seven years from the voting of credits to the commissioning of battleships has been required down to the past year or two—a term which surpasses that which prevails in any other country. Under civil administrators France has reduced the time of construction, and both Italy and Austria have also succeeded in accomplishing the same object. It is now the turn of Russia, which expects, with the assistance of British firms in shipbuilding and in the extension of armament works, to curtail to four years the period for constructing battleships and armoured cruisers, to three years for lighter cruisers, and two years for destroyers and submarines. Why such a long time has been occupied in the past is explained by, among other matters, defects in the naval administration and in the dockyards, whilst miscalculations in the estimates have also led to delays owing to the necessity for awaiting the vote of supplementary expenditure. If these defects have now been overcome—and it is believed that some progress has been made under the present Minister for the Navy—it should be possible for Russia to expedite her shipbuilding programme under the new arrangements with the external aid which is now available. The long duration of the work of construction in the past is not the only disadvantage which has applied to shipbuilding in that country, as the expenditure per unit is excessively high. It is, for instance, actually declared that the cost of constructing a battleship or armoured cruiser is about twice that which obtains either in Germany or Great Britain. If this statement is correct no surprise need be exhibited at the securing of English co-operation in the development of the Russian navy, and at the very large expenditure which is involved in each shipbuilding programme which is submitted to the Duma for approval.

## THE ROYAL SOCIETY'S CONVERSAZIONE.

THE second conversazione of the year of the Royal Society was held at Burlington House on the evening of Tuesday last. As is not unusual, many of the scientific exhibits which are such a feature of these conversaziones, were the same as those which were on view at the conversazione that was held in May, and need not, therefore, be mentioned again; but there were others which are well worthy of mention. As is always the case, the field covered by the exhibits was large. It varied from prehistoric paintings and drawings made by early man in the Palæolithic and Neolithic Ages in Spain and France and a wonderful collection of jewellery belonging to the Egyptian Princess Sat-Nathor-ant, who lived about 3400 B.C., down to such modern things as a specimen of the Daily Record of the weather at the Meteorological Office made on May 1st last.

Much of what was on view had but little connection with engineering or its kindred sciences, and hence do not call for mention in our columns. Taking those exhibits most likely to be of interest to our readers in the order in which they appeared in the catalogue, there was, first of all, a series of photographs illustrative of landslides and upheavals on the Panama Canal, shown by Dr. Vaughan Cornish. The photographs were taken in 1910, 1912, and 1914. That of the Culebra Cut in 1910 showed an upheaval of the solid rock of the canal bottom due to unbalanced pressure of the banks. That of the Naos I. breakwater, taken in 1912, showed the upheaval of the sea bottom at a distance from the subsiding mass of the breakwater. Some photographs of the Cucuracha slide, in 1914, showed the downward flow of inclined strata. The ground was broken for a height of 580ft. above the canal bottom. That of the Paraiso slide showed the final slope taken by a slide in the Culebra Cut.

The British Thomson-Houston Company was giving demonstrations of the Coolidge X-ray tube.

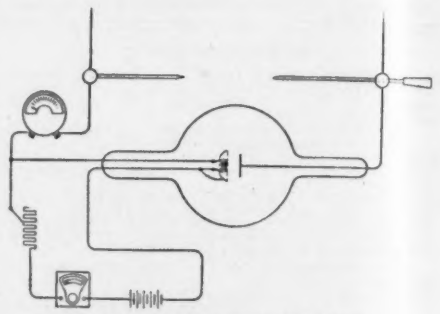


FIG. 1—THE COOLIDGE X-RAY TUBE

This new form of X-ray tube, which is shown in Fig. 1, and which is the invention of Dr. W. D. Coolidge, of Schenectady, differs from the standard form in that the discharge is not carried by a certain amount of gas intentionally left in the tube, but by a stream of electrons shot out from the surface of a heated tungsten spiral forming the cathode. The spiral is flat and closely wound. It consists of a wire 0.216 mm. in diameter and 33.4 mm. long, with 5½ convolutions, the outermost of which has a diameter of 3.5 mm. This tungsten filament is electrically welded to heavy molybdenum wires, to the other extremities of which are welded the two copper wires, these being in turn welded to the platinum wires passing through the glass. To ensure a rigid support for the hot filament the molybdenum wires are sealed directly into a piece of special glass, which has the same coefficient of expansion as molybdenum. The method of mounting the spiral is shown in Fig. 2. The tungsten filament

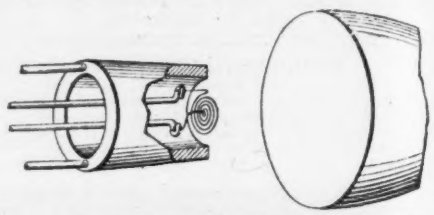


FIG. 2—CATHODE AND ANTI-CATHODE OF COOLIDGE X-RAY TUBE

which forms the cathode is heated by a current from a small storage battery. It is important that this should be carefully insulated from the ground. An ammeter and an adjustable rheostat in the circuit enable the heating current to be regulated with great nicety between 3 and 5 ampères. This range of current gives a potential drop through the filament of from 1.8 to 4.6 volts, the variations of the corresponding filament temperature being from 1890 deg. to 2340 deg. absolute. A focussing device, consisting of a cylindrical sleeve of molybdenum, is provided. Its inside diameter is 6.3 mm., and it is mounted so as to be concentric with the tungsten filament, with its end projecting about 0.5 mm. beyond the plane of the latter. It is supported by the two stout molybdenum wires, which are sealed into the end of the glass tube. The sleeve is electrically connected to one of the filament leads. This, besides acting as a focussing device, also prevents any electron discharge from the back of the heated portion of the cathode. The anticathode, or target, also serves as an anode. It consists of a single piece of wrought tungsten weighing 100 grammes and having an end diameter of 1.9 cm. The anticathode is bound by a molybdenum wire to a molybdenum support, which is of rectangular section and is supported by three split rings, also of molybdenum. The split rings fit snugly in the glass anode arm and serve the double purpose of supporting the anode and of conducting heat away from the rectangular strip, and thus protecting the seal of the inlet lead. The

vacuum is as high as possible—not more than a few hundredths of a micron—and therefore much too high to allow of the production of X-rays in the ordinary manner. The chief advantage of the tube is that both the hardness and intensity of the X-rays produced are under complete and independent control within very wide limits. The current depends almost entirely on the filament temperature. The tube gives at will a homogeneous beam of "soft" radiation—3in. equivalent spark gap—or a "hard" beam—8in. equivalent spark gap. It was being worked from an installation lent by Messrs. Siemens Bros., consisting of a 16in. coil with triple Wehnelt interrupter, capable of giving a wide range of primary current. Very heavy discharges can, we understand, be taken for long periods without damage to the tube, which rectifies its own current, so that it may be worked from either a direct or alternating supply.

Two most ingenious contrivances were shown by Mr. W. M. Mordey. The first was an electrically driven pendulum or balance wheel worked without any make-and-break, commutator, or equivalent device. A simple one-phase alternate-current induction motor with a rotor having a short-circuited winding, in the field of a stator excited by alternate current, develops a torque which is always in the direction of motion. If the spindle of the rotor of such a machine be provided with a pendulum, or with a spring in the manner of a balance-wheel, the rotor, if set in motion, will continue to oscillate, friction and other losses—or any load put on it—being made up by energy taken from the circuit. In the actual exhibit the motion was shown both with a pendulum and with two oppositely wound springs. The second device was intended to show a novel mode of commutation. In place of the usual commutator, a small vertical shaft direct-current armature has its commutator connections dipping into a circular trough of mercury which shunts the armature. Sparkless commutation takes place in the mercury, into which the current is led at points corresponding to the ordinary brush positions. Intermediate coils are not affected, as the fall of potential through the armature is the same as that through the shunting trough or ring. The armature revolved just as though it had an ordinary commutator and brushes.

Close by, Dr. E. E. Fournier d'Albe had in operation a working model of a type-reading optophone, which had been designed to enable totally blind persons to read ordinary books and newspapers by means of the ear. A perforated disc rotates in front of a Nernst lamp and produces a bright line consisting of dots giving flashes of different musical frequencies. An image of this line is thrown on the type, which reflects the light on to a selenium bridge. Each letter gives a characteristic sound, which is heard by means of a telephone attached to a Brown telephone relay. It is necessary, of course, for the blind person to learn the particular sound associated with each letter.

The next exhibit was that of Lt.-Col. G. O. Squier, and represented a collection of instruments intended for "wired-wireless" telegraphy on telephone lines. It was explained that an endeavour had been made in the apparatus to link the older art of wire telephony with the newer art of radio-telegraphy and telephony. The regular standard telephone wires are utilised as antennæ for guiding and absorbing the electromagnetic energy required in radio-telegraphy. One of the wires of the regular standard metallic circuit of the telephone system is utilised to carry simultaneously:—(1) The ordinary battery telephone conversation; (2) the wired-wireless signals sent and received by electromagnetic waves of ultra-sound frequencies; and (3) the reception of radio-telegraphic signals from a distance. There is, it was stated, no mutual interference between the operation of the two systems.

The next apparatus to claim attention was that for measuring the degree of pollution of the air by smoke, which was shown by Dr. J. S. Owens. In this a measured volume of air is drawn through a small disc of thick filter paper, leaving thereon a permanent record of the quantity of impurity present. This takes the form of a discolouration, the degree of which indicates the amount of suspended impurity. The apparatus is intended to enable the purity of the air of cities to be compared and records kept, as hitherto no simple method of doing this has been available. An observation can be taken in about ten minutes, and the apparatus is so simple that no expert knowledge is required to use it.

Mr. Louis Brennan, C.B., was giving demonstrations of the Iridoscope, which is an instrument for showing the interference colours produced on a flat soap film by reflected light. The variegated colours are caused by differences of thickness of the film and their motions by a jet or jets of air impinging on the surface. A large soap film was carried in a frame which could be extended or reduced in area so that the different colours corresponding to the varying thickness of soap film could be observed.

Mr. C. R. Darling was once again showing his surface tension phenomena, and an experiment to show the structure of liquid jets. We referred to this interesting exhibit in our review of the last conversazione.

Finally, mention may be made of a terrestrial globe shown by Mr. George H. Gabb. The terrestrial globe, which is dated 1620, was constructed to serve as a timepiece, and it was supported by a gilt bronze figure of Atlas. The globe was made by the famous cartographer, Joannes Janssonius, successor to Mercators' house in Amsterdam, and is one of the earliest globes extant, and probably unique. It is formed of two hemispheres of copper, on which is an engraved map of the world on paper, arranged in gores. The engraving is probably by the hand of Peter Kerius, perhaps the finest map engraver of that period. Inside the globe is a movement of the verge type, made by Johann Tomas Seyler, a contemporary clockmaker, so geared to the axial spindle that the globe revolves once in twenty-four hours, the time of which is regulated by the primitive method of altering the tension of the main spring by means of an endless screw and tangent wheel geared to it. Attached to a point on the equator is a small star, which indicates the hour on a dial band as the globe revolves.

## MINING EXHIBITION IN MANCHESTER.

No. I.

THE second exhibition promoted by a body calling itself the Northern Mining Industries Exhibitions' Committee, which was formed in 1911 for the purpose of controlling such displays in the North of England, is now being held in the City Hall, Manchester. Manchester is the appropriate centre for such an event, owing to the proximity of this city to the Lancashire coalfields and its ease of access from the other coalfields of the country. In addition to this reason, Lancashire engineers play a considerable part in providing the mechanical equipment of collieries. Special interest is centred in the present show on account of the increasing stringency of the regulations which are being imposed by Parliament upon mine owners. Although the exhibition is neither very extensive nor noteworthy for many new appliances, it nevertheless contains modern examples of the leading types of coal-cutting machines, hauling and winding engines, cage gears, washing, screening and loading plants, rescue apparatus, lamps, and ambulance equipments, together with the *olla podrida*, which is "at home" at any exhibition of engineering appliances.

Coal-cutting machinery is shown by several firms, including Messrs. J. Gillott and Son, Barnsley; the Hurd Coal Cutter and Engineering Company, Limited, Glasgow; A. Hirst and Son, Limited, Dewsbury; Jeffreys; and Richard Sutcliffe, Horbury, near Wakefield. The motive mechanism for these machines is operated either by electricity or compressed air, and there seems to be an increasing disposition on the part of mine owners to adopt the latter. This is not entirely due to prejudice, for the users of electric power have to conform very closely to the strictest regulations to ensure safety. It is becoming increasingly apparent that, having regard to the trend of legislation and the demands for better payment for labour, together with the increased rates and taxes, the cost of raising and getting coal will continue to increase, and it behoves colliery proprietors to give their earnest consideration to appliances for economising the working of their property. There is little doubt that the use of mining machinery reduces the cost of getting the coal, and the coal so obtained is in better condition than that got by hand. The most arduous work is done away with and shot firing is largely avoided. Mr. Richard Sutcliffe's coal cutter is of the air-operated disc type and made in two sizes, the larger having cylinders 9in. stroke by 9½in., and the smaller having 8in. by 8in. cylinders. Motion is transmitted from these pneumatic motors to the cutting discs by means of a train of spur gearing of crucible cast steel of very substantial design. All the working parts run in oil and are easily accessible for renewal or repair. The hauling drum operated by the same motor is readily thrown in and out of gear by a lever and clutch arrangement, which obviates any slipping of the drum on the cone.

The coal cutters shown by A. Hirst and Son, Limited, are also of the disc type, one being operated by an electric motor and the other by compressed air. It is built in two sizes with cutter wheels from 3ft. to 6ft. diameter. The cylinders, bearings, and gearing are kept constantly flooded with oil by means of a pump, the oil being used over and over again. In order to give silent running the gears are all machine cut, while the exhaust of the motive fluid is also silenced. The Hurd coal cutter is of the bar type, and is 16in. high, so as to be able to work in a 17in. seam. It is built to be operated either by compressed air or electricity; in the former case the cylinders are 7½in. bore by 4in. stroke. A feature of the machine is the provision on the outer bearing of the cutter of a loose cap for cleaning without interfering with the bar or the loss of oil from the gear case. The crank shaft is of nickel steel with four large bearings, and all the gear wheels are of mild steel, machine cut and casehardened. A larger sized machine of the compressed air type has cylinders 10in. by 5in. and is 33½in. high with governor.

Hauling engines occupy a considerable portion of the exhibition, and there is not much that requires to be said about their design and construction. The exhibitors include:—Allen Barton and Co., Limited, St. Helen's Junction; the Falcon Ironworks, Limited, Oldham; T. and R. Lees, Hollinwood, near Oldham; the Yorkshire Engine Company, Limited, Sheffield; and Hugh Wood and Co., Limited, Newcastle-on-Tyne. Messrs. Lees show a pair of 6in. by 10in. self-contained geared hauling engines with a single drum, suitable for either steam or compressed air working. The set is mounted on steel girders, and is fitted with a powerful double post brake. This firm also shows a stop valve for steam engines, which is operated by an electromagnetic device in case of emergency. This valve is claimed to be particularly applicable to endless rope haulage systems, where accidents, due to the derailing of tubs, render instant stoppage of the engine necessary. By means of a simple solenoid device a trip is released, and this in turn actuates a weighted arm which closes the steam valve through a system of levers; at the same time an audible warning is given by means of a bell.

The extensive employment of stone dust for minimising or preventing the spread of fires due to explosions in mines has caused a demand for grinding mills for the economical production of this material. A ball mill for this purpose is shown by Wm. Johnson and Sons (Leeds), Limited. It is a self-contained crushing, grinding, and screening plant, the three processes taking place in the one machine. Pieces of shale or "bind" up to 6in. cube can be fed to the mill, and the stone dust is delivered to the fineness required into bags or tubs as preferred. It is a slow-speed mill, therefore the power for driving and wear and tear are reduced to the lowest point. Being fitted with a dust cover, to which a ventilating shaft can be attached, there is no dust nuisance in the grinding-room.

Air compressors are well represented. Tilghman's Patent Sand Blast Company, Limited, is to the fore with an electrically driven air compressor with a capacity of 500 cubic feet of free air per minute, which runs at 420 revolutions per minute. It is of a type that is familiar to most of our readers, and has multiple silent acting disc valves and unloading device. The Lilleshall Company, Limited, Oakengates, shows in operation a very compact compressor capable of compressing 26 cubic feet of free air per minute to 300 lb. pressure when running at a speed of 280 revolutions per minute. It is driven by means of a belt from an electric motor, and is of the single-cylinder double-stage type with intercooler. The two-stage compression is effected by means of a differential piston, the first stage of compression taking place in the space between the rear side of the piston and the back cover of the cylinder, the second stage taking place in the annular space between the trunk end of the piston and cylinder wall. The cylinder is water jacketed, and the air on its way from the low to the high-pressure side of the cylinder passes through an intercooler of ample capacity, attached to the top of the cylinder and provided with brass tubes through which water circulates. The frame is of the forked type; in the smaller sizes it is cast in one with the cylinder, but in the larger compressors the frame and cylinder are cast separately. The connecting-rod is a mild steel forging. The crank pin end is fitted with brass steps or cast steel steps lined with white metal, and the wrist pin end is provided with a hardened steel bush or adjustable gun-metal steps. These compressors are fitted with the Rogler-Hoerbiger steel disc valves, which give a large opening with a very small lift.

We shall refer to other exhibits of interest in our next week's issue.

## LITERATURE.

### SHORT NOTICES.

*Flying: Some Practical Experiences.* By Gustav Hamel and Charles C. Turner. London: Longmans, Green and Co. Price 12s. 6d. net.—Our bookshelf for aeronautical works is already overcrowded, but no matter what has to be discarded this book must find its place on it. Books there have been by the score on the theory of flight and on the practical construction of aeroplanes. But this is the first volume we have come across which deals solely with the aviator's side of the matter. It is a more or less "popular" but thoroughly serious work. It deals with such questions as aptitude for flying, cross-country and oversea flying, aerial touring, and the cost of flying. These matters possess an interest even to those who have no thought of taking up aviation seriously, whether as a hobby or a profession, and to such the book will be found almost enthralling. But to those who are so contemplating the art it should come as a veritable guide and companion. We may add that "a naval officer of high rank" contributes a chapter on the aeroplane in war, that there is a chapter on wireless telegraphy as applied to aeroplanes based on notes contributed by Mr. Marconi, and that Mr. J. Elrick Adler contributes a valuable memoir on the medical aspect of aviation. The book is illustrated with some remarkable photographs. Since this was written the news of Mr. Hamel's misfortune—changed later to the certainty of his death—has been received by all with the utmost regret. It seems fitting that in reviewing this, his, we believe, first and last publication, we should express our sorrow that all his skill and knowledge were not sufficient to save him from the dangers against which he and Mr. Turner warn others in this book.

*A Text-book of Geology.* By James Park. London: Charles Griffin and Co., Limited. Price 15s. net.—This volume contains nearly 600 pages, and well over 300 illustrations. It deals with general geology rather than economic or applied geology, and is intended for use in mining schools, colleges, and secondary schools. It cannot perhaps be said to fulfil a distinct want, but as a general introduction to all aspects of geological science it leaves very little to be desired. The author is Professor of Mining in the University of Otago, and has the born instructor's clear style of exposition. To this he adds the happy knack of being able to make even the dullest portions of his subject alive and interesting. The book, like other general treatises on geology, is divided into two main portions, the first one dealing with dynamical and structural geology, petrology, and palæontology, and the second with stratigraphy. These subjects do not permit of any treatment differing greatly from the orthodox, and it is only in places that the author has succeeded in differentiating his work from others. Nevertheless, the book is certainly to be commended to all desiring a full and accurate introduction to modern geology. By way of criticism we may say that a little more care spent on some of the illustrations would have been well repaid, and that to readers in this country at least the illustrations and examples relate too frequently to the geological features of New Zealand—the author's home—or to America—the home of the prolific United States Geological Survey.

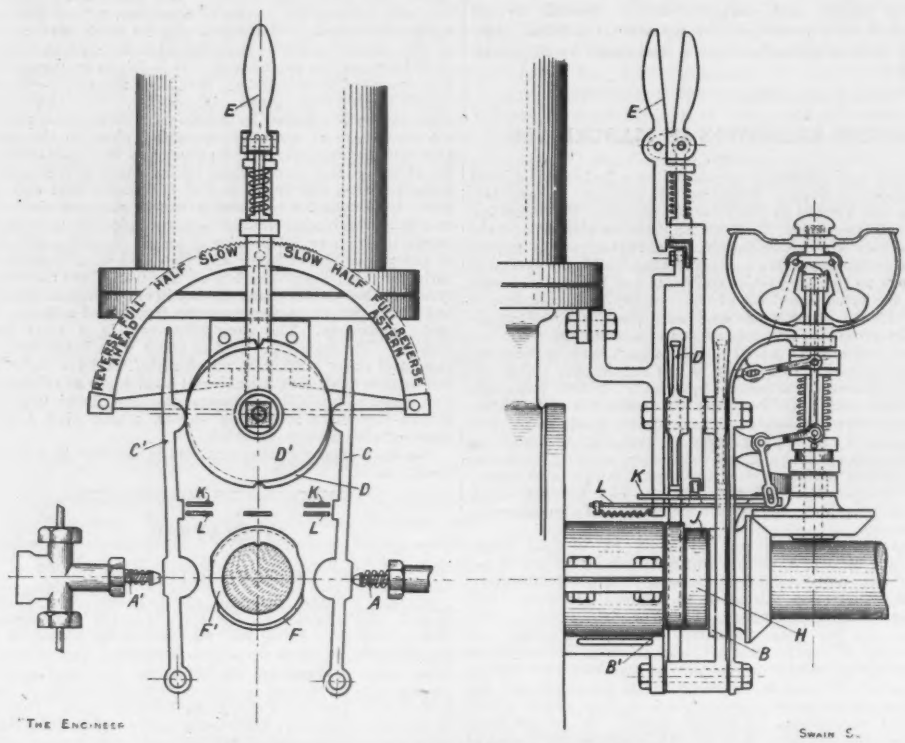
*Steam Pipes: Their Construction and Arrangement.* Manchester: The Vulcan Boiler and General Insurance Company, Limited. Price 1s. net.—This publication deserves the most careful attention and study of all engineers who are responsible for the upkeep or design of steam pipes of all classes. It is based on the actual experience of the company, and deals with such subjects as the drainage of pipes, water separators, and steam traps, the material for and the methods of constructing steam pipes, temperature movements, joints and supports, valves in steam pipes, and radiation losses. The book is filled with practical information, and should be of immense service to practical people.

## DIRECTLY REVERSIBLE HOT BULB ENGINE.

THE idea of reversing a small motor by firing the charge on the rising stroke of the piston is quite old, and the use of the method in engines of large power—by altering the time of admission of the fuel instead of the time of the ignition—is undoubtedly making headway. The Bolinder was, as far as we are aware, the first engine of more than nominal power in which the plan was adopted, and we must admit that we viewed it with no little disfavour; to our mind it still does not look sound practice to pull up a big fly-wheel with some suddenness and tell it to go the opposite way, enforcing the command by firing a charge right in its face. The motor has, however, accustomed us to many unmechanical looking ideas, and proved that they work better in practice than theory would seem to indicate. The success of the Bolinder has tempted another firm to follow the same lines, and the hot bulb engines which we understand will shortly be put on the market by the Mitcham Motor Company, of Cowes, will embody this method of reversing. The ordinary details of the Mitcham engine, as far as the design has been carried up to the present, are on the usual hot-bulb lines, with crank case compression, &c., until we come to the fuel admission arrangement. But before passing to the real subject of this article, we should like to express a word of admiration for the blow lamp used for the preliminary heating of the bulb. In place of the heated vaporiser round the nozzle of the lamp, an ordinary scent spray nozzle is provided, through which the paraffin is blown by compressed air from a small supply tank. This spray can be immediately ignited by means of a torch without the need for the heating of any vaporiser. This, of course, entails the complication of a compressor, but in the case of a multiple-cylinder engine we are not at all sure that it is not preferable to the multiple blow lamps of the ordinary form, each of which, of course, has to be pumped up by hand, and has in addition to have the preliminary heating; at all events, we fancy an engine would be very much less trouble to get under way with the "scent spray" lamp than with the ordinary blow lamps.

We may now confine ourselves entirely to the fuel feed which is arranged to give the pre-ignition reverse. The first requisite, of course, is to inject fuel into the cylinders, and this is done by means of cam-operated fuel pumps A $A^1$, one for ahead and the other for astern. These pumps are operated by cams B $B^1$ on the crank shaft through the interposition of the vertical rockers C $C^1$. The upper ends of these rockers press upon excentric discs D $D^1$, which are attached directly to the reversing lever E. These discs are so arranged that when the lever is in the ahead position the astern pump rocker will be pushed out of reach of its cam, and *vice versâ*. The action will probably be most easily understood if we now describe what takes place on starting up. To go ahead, the lever E is pushed over into the full ahead position; that is to say, to the left-hand side of the quadrant shown in the illustration. This causes the pump lever C to rise on the high side of the excentric disc D, so that it is clear of the cam F, while at the same time the lever $C^1$ drops on the low side of the disc $D^1$, and so brings the lever into contact with its cam $F^1$. Then, by turning the fly-wheel in the ordinary way, fuel is admitted and the engine starts. To obtain the reverse, the lever E is thrown over to the opposite side of the quadrant, which puts the rocker $C^1$ out of contact with its cam, and puts the rocker C into contact with its cam.

It might at first right appear that we have here all the necessary elements for ahead and astern running, but there is as yet no provision for admitting the pre-ignition charge which is required to catch the piston on its rising stroke, while the engine is still running, so as to start it off in the opposite direction. To effect this, the cams are mounted loosely on the shaft and driven by a pin J fixed in a collar H, which is fast to the shaft, the pin projecting into annular slots cut nearly all round the faces of the cams, and forming an arrangement similar to the loose excentric on the low-pressure cylinder on some of Webb's compound locomotives. The cams are so set in relation to each other that when $F^1$ is being driven so as to give the proper fuel feed for running ahead, the cam F would admit the charge on the rising stroke of the piston, and it is only when that charge has been fired and the engine has actually started in the opposite direction that the pin J is carried round by the shaft till it picks up the opposite side of the stop in the annular groove, and so alters the setting of the cam, so as to admit all future charges at the correct moment to allow the engine to continue running in that direction. In other words, reversing is effected by pre-ignition; therefore the cams must remain in the position for running in a given direction till pre-ignition has taken place. Hence, this lag in the movement of the cam must be allowed for. Once pre-ignition has taken place the cams automatically set themselves in the opposite direction.




REVERSING GEAR OF MITCHAM HOT BULB ENGINE

The action of the governor must now be explained. Attached to the weights is a wedge piece K which is interposed by the action of the governor between the rockers C and $C^1$, and slides to and fro in accordance with the position of the governor balls, so that the rockers can move a greater or less distance towards the centre of the shaft according to the position of the governor, thus varying the length of the stroke of the fuel pumps. This operation, of course, only concerns the control of the speed of the engine when running. The governor is, however, necessary in order to slow down the engine to a speed at which it is safe to admit the pre-ignition charge in order to obtain the reverse. For this purpose a second wedge piece L is fitted, normally held clear of the vertical rockers by means of a light spring. When the reversing lever is moved from ahead to astern, it pushes this wedge piece L into the position nearest the cylinder where the greatest width of the wedge will serve to keep both the rockers C and $C^1$ out of contact with their cams, and it is held there by the interposition of a locking bar attached to the governor. Thus the fuel is entirely cut off from the engine until it has slowed down to the required speed, when the governor withdraws the locking bar and at the same time releases the piece L, so that the pump lever for the required direction of rotation can get into contact with its cam. This immediately gives the pre-ignition charge as described above, and the engine is reversed. Thus it will be seen that all the movements necessary to reverse are controlled by a single lever, and no care or watchfulness on the part of the engineer should be required in slowing his engine down or in noting the correct time for the admission of the pre-ignition charge; it is certainly a very ingenious arrangement, though our obsevations do not allow us to state whether it actually performs its functions properly, as on the occasion of our visit the strength of the governor spring had not been adjusted to meet new conditions which had been introduced, and a little assistance by hand was required at the moment of reversing. There is one point to be borne in mind in connection with this method of reversing, and that is that a charge of the ordinary volume is not sufficient to give power enough actually to start the engine in the opposite direction; this, by the way, tends to show that the stresses must be fairly severe. In order to obtain the necessary increase in the charge, projections are provided on the back side of the nose of the cam which engage with corresponding projections on the pump rocker—only when the engine is running in the direction opposite to that for which the fuel pumps are set—and give a blow on that rocker which greatly increases the length of stroke, and so the charge to about five times the normal.

Another point in connection with this reverse arrangement is that it is certainly not so rapid in action as the ordinary reversing gear, as, when the lever is thrown from ahead to astern, the engine runs on in the ahead direction for several seconds before it has slowed down to a safe speed for reversing. The time actually occupied from the first movement of the reversing lever to the first revolution in the opposite direction appears to be generally about ten seconds, but we should think that it would be quite possible to apply a brake to the fly-wheel in order to reduce this in case of any emergency, though a certain amount of skill and care would undoubtedly be required in bringing it into operation, as carelessness might result in the complete stopping of the engine, and the cure would be worse than the disease.

The particular engine which we saw was one with a cylinder 7in. diameter by 8in. stroke, giving 10 horse-power at 400 revolutions per minute with a consumption of about 0·675 lb. of solar oil per brake-horse-power per hour.

## HUMPHREY PUMPS FOR THE EGYPTIAN GOVERNMENT.

AN installation of Humphrey pumps has been ordered by the Ministry of Public Works of the Egyptian Government for the drainage of Lake Mareotis at Mex, near Alexandria. When completed, this plant will be one of the largest pumping installations in the world, and will consist of eighteen enormous pumps, each capable of delivering 100,000,000 gallons per day through a lift of 20ft. The present order includes the first ten of these pumps, together with the necessary gas producer plant, Venturi water meters, travelling cranes, locomotive weighbridge, regulating gates and screens and a complete gas-driven electric light and power installation.

The great size of the pumps may be judged from the fact that each unit is to be capable of delivering between two and three times that delivered by each large Humphrey pump unit installed at the Metropolitan Water Board's pumping station at Chingford. It will be recalled that the large pumps at Chingford—fully described in THE ENGINEER of March 14th and 21st, 1913—have an output of 40,000,000 gallons per day each. The pumps comprised in the present contract have been designed with the aid of the valuable experience obtained with the Chingford station, and will include many improvements, although operating on the same cycle. The following approximate dimensions of the pumps for Mex will be of interest.

The combustion chamber will have a maximum internal diameter of 8ft. 8in., and its height will be about 14ft. The water valve box will be 8ft. 8in. diameter and 7ft. high, and will be fitted with 100 valves of the hinge type, specially designed to enable any valve to close upon an obstruction, such as a piece of wood, without throwing undue stress on the hinges. The design is such that on the next stroke, when the obstruction has been removed by the rush of water, the valve will automatically readjust its position and close fairly upon its seat. This type of valve is a result of careful experiment and test.

All the main castings will be of steel, and will be carried upon a cast steel bend connected to the play pipe. This bend will be in two parts, making up the 118·5 deg. required to connect with the inclined play pipe. At Chingford the bend has an angle of 90 deg., and is connected to a horizontal play pipe, which in turn is connected through a second 90 deg. bend to a vertical conical water tower. At Mex, however, there will be only one bend, and the play pipe will slope upwards, so as to deliver the water at the required elevation in the discharge basin. In order to reduce the velocity of the water at the exit, the play pipe will end with a long conical portion, giving a 12′ diameter outlet. Not only does a sloping play pipe eliminate one of the bends and give rise to a simpler construction, but it has, we are told, the additional advantage that the vertical components of the forces due to momentum of the moving masses of water in the combustion chamber portion and play pipe portion respectively are balanced.

Five of the pumps will be made by Wm. Beardmore and Co., Limited, of Glasgow, and five by the Tecnomasio Italiano Brown Boveri, at Milan. The anthracite gas plant, capable of gasifying 44 tons per day, will be of the self-vaporising type, and will be supplied by the Power Gas Corporation, Limited. There will be nine producers, one of which will be a spare. The producers will be of the luted type. The gas from the collecting main will pass through two large gas cooling towers, and then through dry scrubbers into a gas holder of 10,000 cubic feet capacity, which, besides forming a mixing chamber for the gas, will be used for accurately measuring the gas during the official trials of the plant, although for ordinary purposes the gas will be measured through a rotary meter.

The plant for electric power and lighting will comprise two gas engines, each of 180 brake horse-power normal load of the two-cylinder horizontal type, running at 190 revolutions per minute, and direct coupled to 120 kilowatt 220-volt generators. The lighting will be partly by arc lamps, partly by incandescent lamps, and the capacity of the plant will be such that one unit will normally run the whole of the electrically driven auxiliaries both at the producer plant and at the main pump-house. As this plant has to start operation in order to supply current to the large overhead travelling crane, and for working the centrifugal drainage pumps during excavation, it will be supplied with a 200 horse-power suction gas producer plant for temporary use, until the main plant is at work.

There will be two Venturi meters supplied by George Kent, Limited, each arranged to measure the water delivered from one or more pumps up to a total of five. These meters will be of square section and 12ft. by 12ft. in the throat. Continuous recording apparatus and counters will be fitted to show the rate of pumping and the quantity of water delivered, and will be electrically connected to the recording instruments placed in the pump-house. The meters are guaranteed to be accurate within 1¼ per cent. Except that the throat diameters will be lined with gun-metal to ensure smooth and accurate stream-lines, they will be mostly constructed of ⅜in. steel plates bolted to rolled steel joists and jointed with lead strips. The meters will be partly supported in the natural rock as excavated and partly by concrete walls.

There will be a railway weighbridge at the entrance to the sidings for the main installation, having a capacity of 60,000 kilos., and made sufficiently strong to take a locomotive up to 75 tons. It will be of the patent extension type manufactured by Henry Pooley and Sons, Limited, and will carry a ticket printing steelyard. This weighbridge will be a combination of two self-contained machines, one weighing up to 40,000 kilos., and the other

# THE ENGINE-ROOM OF THE MOTOR SHIP ARUM

SWAN, HUNTER, AND WIGHAM RICHARDSON, LIMITED, WALLSEND-ON-TYNE, ENGINEERS

(*For description see page* 684)

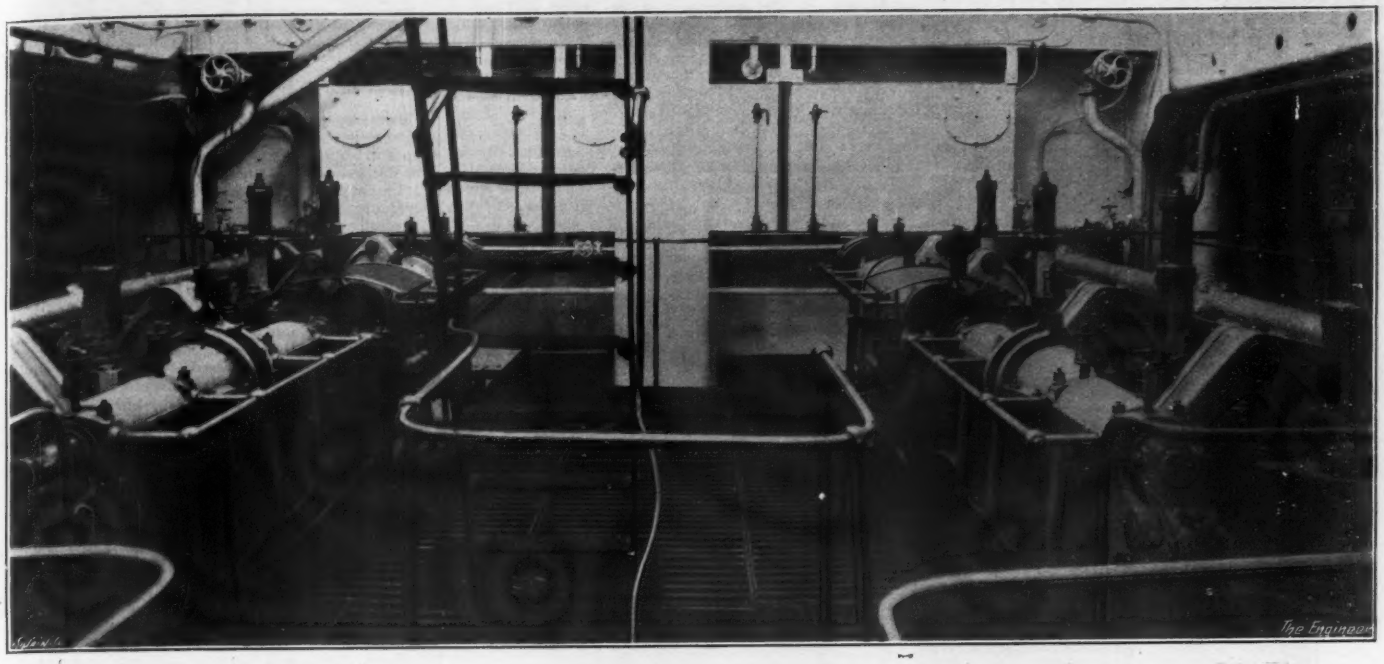



Fig. 1—UPPER PLATFORM

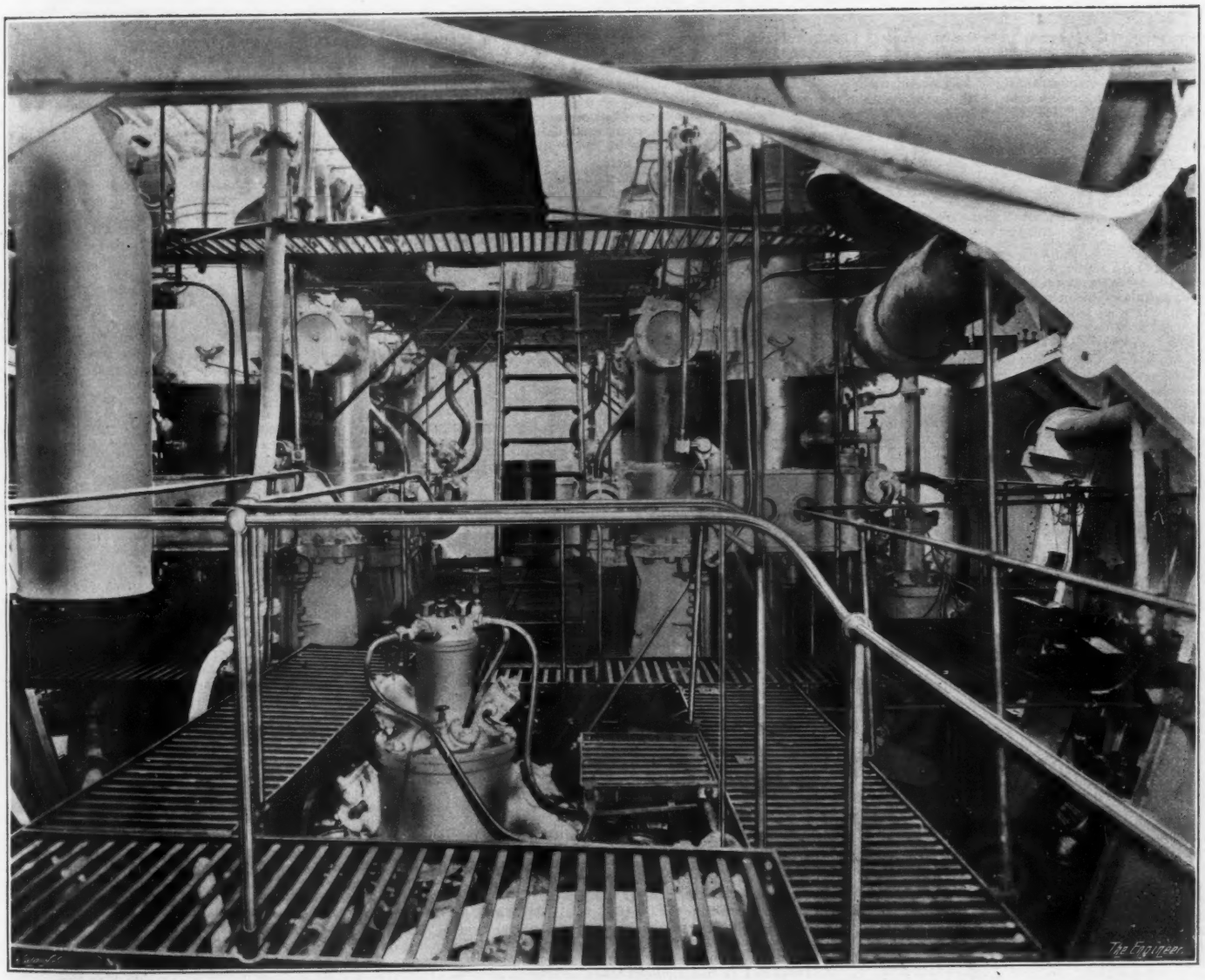



Fig. 2—MIDDLE PLATFORM

up to 20,000 kilos., and the overall length will be 42ft.

The electric crane in the pump-house will be capable of lifting up to 30 tons, and will have separate motors for the two lifting speeds and for longitudinal and transverse motions. The span will be about 35ft., and the crane will be built and supplied by Jos. Booth and Brothers, Limited, Rodley.

There are other items included in the installation which need not be mentioned in this preliminary notice, but it should be stated that the whole of the work will be carried out under the supervision of Messrs. Harper Brothers and Co., who are the consulting engineers to the Egyptian Government. They have prepared the specification and plans, and have designed the handsome buildings which will become a landmark in the neighbourhood of Alexandria.

## THE MOTOR SHIP ARUM.

ON page 683 we give some further illustrations of the engine-room of the motor ship Arum, which we described in our issue of the 29th ult. Fig. 1 shows a view of the tops, from which the simplicity of the valve gear can clearly

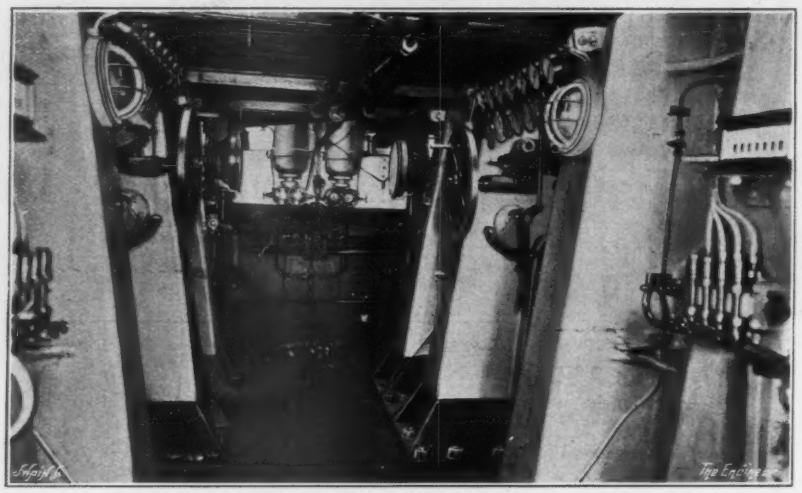


Fig. 3—STARTING PLATFORM OF THE MOTOR SHIP ARUM

be seen, and also the covering in of the cam shaft. Fig. 2 gives a good idea of the space between the engines on the middle platform. Fig. 3 on this page shows the levers and hand wheels for manœuvring the engines, certainly a less involved arrangement than with most steamers of to-day. The starting platform will be seen to be beautifully clear of obstructions.

## THE ACCIDENTS TO RAILWAY SERVANTS INQUIRY.

No. II.*

MR. J. P. SCOTT MAIN, an assistant inspecting officer of the Board of Trade, followed Colonel von Donop on Tuesday, the 9th inst., and said that it was his duty to analyse, tabulate and classify the accidents to railway servants. He also recommended to the chief inspecting officer what accidents should be inquired into. Mr. Main was, in addition, the secretary to the Railway Employment Safety Appliances Committee, the members of which were now Colonel von Donop (chairman), Sir Robert Turnbull and Mr. J. E. Williams. The sum of £2500 had been voted by the Treasury towards the cost of any experiments the Committee made, and of this nearly £1000 had been spent—none of this had gone to inventors, nor, Sir Robert Turnbull remarked, to the Committee.

The Committee had had sixty-five meetings to date and fourteen reports had been issued, the first eight of which had been printed and published. There had been nineteen trials of automatic couplings and either-side brakes, and 223 models of them and of fog-signalling appliances, warnings for platelayers, &c., together with numerous drawings and descriptions had been inspected. Most of the reports as to these things were of a negative character. The Committee still continued to examine and consider anything submitted to it, but nothing of note had yet been forthcoming.

Automatic couplings was one of the subjects to which the Safety Appliances Committee had paid considerable attention. On this matter Colonel Yorke prepared for the Board of Trade a memorandum dealing with the difficulties in the way of providing automatic couplings, and pointing out that the question was one of national importance and one for the Government to decide—(1) Whether, having regard to the small number of accidents in this country due to the present method of coupling and uncoupling goods wagons, there was such necessity for a change from the existing type of coupler as to justify the large capital outlay and the dislocation of traffic which would be inevitable? (2) How, if the change was decided upon, the enormous expenditure connected therewith was to be met. (3) How the owners of private wagons were to be dealt with; and (4) how the dislocation of traffic and risk of accident to men and trains during the experimental and transition stages were to be faced.

This memorandum was referred by the Board of Trade to the Safety Appliances Committee for its views as to whether in the then circumstances it was advisable that investigations and experiments should be undertaken with regard to automatic couplings. After very full consideration the Committee decided that it appeared impracticable to fit appliances of such a character to existing wagon stock, and consequently any extensive tests of automatic couplings would be of no value. The Committee, however, suggested that possibly some improvement in the method of utilising the existing three-link coupling might be discovered. Inventors were advised as to this, and models and full-size couplings were subsequently inspected and tested, but with no satisfactory result.

The attentions of the Committee were confined to safety appliances. At the suggestion of the Board of Trade it directed its energies on certain features prominent among the causes of accidents during 1906. These were:—Exchanging tablets or staffs; men engaged upon the permanent way being struck by trains or engines; capstan working; men on engines in motion whilst absent from the footplate; working in or about wagons; in horse shunting; coupling and uncoupling; crane cog wheels; fly shunting; and the bursting of locomotive gauge glasses.

A recommendation was made as to exchanging tablets and staffs, that *i.e.*, mechanical apparatus be used, or speed reduced, when exchanging by hand, to ten miles per hour. This was adopted by the companies. The accidents to men working on the permanent way were covered by the new rules that came into force last year. It had also been agreed to equip gauge glasses with an automatic shut-off valve at the bottom and partially to close in the back of the glasses as well as the sides.

Since then four other subjects had been referred to the Committee for consideration. They were accidents to men (1) falling from signal posts, (2) when coupling or disconnecting steam-heating pipes, (3) through the loops on wagons breaking when used for tow-roping, and (4) when using brake sticks for controlling wagons. Recommendations as to these points had been sent to the Railway Clearing House, but had not been accepted. The reasons given were (1) that long-burning lamps were now being generally used and they only needed attention once a week, (2) that the instructions given to turn off the steam before disconnection were adequate, (3) the proposal of the Committee that the loop should be strengthened would be borne in mind and in the meantime the matter would be watched, (4) the Railway Clearing House considered that the proposed guard would interfere with the examination of the wheel. All the recommendations of the Safety Appliances Committee had been unanimous.

When the Committee resumed its sittings on the 12th instant, Mr. Main was examined by Mr. Hudson, whom he told that nothing had been done with regard to automatic couplings to passenger stock. The Safety Appliances Committee had inspected a large number of full-sized equipment and models to deal with three-link couplings, and one or two possessed features which might be developed. Any automatic coupling must be uniform for all the companies. No recommendation had been made as to a standard length of buffer and space between wagons. There were no applications before the Safety Appliances Committee just now for full-sized equipment to be tried, but there were three models. A meeting of the Committee would be held before the end of the half-year. The companies might have, without the knowledge of the Committee, some either-side brakes or couplings on trial. To two inventors it had been suggested that they should apply to the companies for permission to test their ideas. There were very few such cases.

When Mr. Main was asked by the Chairman as to whether the Committee possessed sufficient powers, he replied that he could suggest no change. On being pressed he said that it must not be forgotten that they had no control over methods of working; they only dealt with appliances. Mr. Marwood, re-examining, drew from the witness the information that before the Committee abandoned the idea of an either-side brake being applied and released from either side it got out a return as to the accidents caused in applying and releasing, and found that 80 per cent. were caused by the former. It therefore felt justified in dropping the release from either side.

Colonel von Donop followed with certain information he had been asked for at the preceding sitting. He put in a table as to the ratio of accidents, fatal and non-fatal, to the number employed from 1898 to 1913, after clerks and mechanics had been deducted. The percentage of movement accidents in 1898 was 1·094, and in 1913 it was 1·235. In non-movement the percentage in 1898 was 2·069 and in 1913 4·679. Colonel von Donop subsequently promised to separate the fatal and non-fatal cases in this and the next table he handed in. This latter covered accidents to shunters from 1895 to 1913. In 1895 there were 7092 shunters to whom 358, or 5·048 per cent., accidents occurred. In 1913 there were 15,095 shunters, who met with 1038, or 6·864 per cent., of accidents.

After a table as to the increase in the number of passengers and tonnage of minerals and general merchandise had been handed in, the witness presented a table of the percentage of fatal and non-fatal accidents to the number of men employed in the principal grades. This showed:—

| | Fatal. | | Non-fatal. | |
|---|---|---|---|---|
| | 1889. | 1913. | 1889. | 1913. |
| Goods guards .. | 1 in 201 | 1 in 535 .. | 1 in 25 | 1 in 16 |
| Permanent way men | 1 in 596 | 1 in 611 .. | 1 in 527 | 1 in 285 |
| Engine-drivers .. | 1 in 843 | 1 in 1106 .. | 1 in 66 | 1 in 53 |
| Firemen .. .. | 1 in 569 | 1 in 1243 .. | 1 in 48 | 1 in 34 |
| Shunters .. .. | 1 in 191 | 1 in 444 .. | 1 in 17 | 1 in 15 |
| Porters .. .. .. | 1 in 636 | 1 in 1142 .. | 1 in 88 | 1 in 96 |
| Passenger guards.. | 1 in 839 | 1 in 702 .. | 1 in 51 | 1 in 65 |
| Labourers .. .. | 1 in 850 | 1 in 2816 .. | 1 in 243 | 1 in 389 |

Mr. Bury pointed out that although there was a large increase in shunting and in shunters, the number of accidents in shunting was the same—88—in 1913 as in 1901. He wanted all the tables handed in to have a footnote as to the change made in 1906 as to reporting non-fatal accidents having affected the number. To Sir Robert Turnbull witness said that he could not say whether the increase in non-fatal cases was due to the men more readily leaving work for trivial causes, nor if the increase in the number of men employed was due to the hours being reduced. Braking and coupling were the principal causes of accidents, and braking mishaps would be reduced when the either-side brakes ordered by the Statutory Rule of November, 1911, were in general use. As to coupling, the witness said that he had seen nothing to replace the coupling stick, which was an efficient tool. It was liable to be caught in the wheels, but was the best thing yet seen. In fly-shunting there was one fatal accident in 1909 but none since, and only 14 non-fatal accidents in the last five years.

The Committee then rose until Tuesday, July 7th, at 10.30 a.m.

* No. I. appeared June 12th.

## 40-TON STEAM TITAN CRANE.

A LARGE steam Titan crane has recently been completed by Stothert and Pitt, Limited, of Bath. It is intended to be used for block setting in connection with the new harbour works now being constructed at Fishguard by Topham, Jones and Railton, Limited, and may be used to set the blocks either symmetrically or pell-mell, or with inclined bond.

The crane, drawings of which are given in our Supplement, has been constructed to lift loads of 40 tons at a maximum radius of 125ft., and is provided with hoisting, slewing, racking, and travelling motions. Two lifting speeds are provided, the full load of 40 tons being raised at 8ft. 6in. per minute, and a load of 7 tons at 48ft. per minute. The hoisting barrel has been given sufficient capacity to enable the hook to descend 80ft. below the level of the rails on which the crane runs. The load, we may add, is lifted on eight parts of rope.

The cantilever jib is arranged to make one complete revolution in three minutes. It revolves on a live ring of steel rollers and slewing is effected by means of a pinion gearing with a large circular rack fixed below the turntable. The range of traverse for the racking motion is 97ft., and the load is racked to and fro on a jenny by means of steel wire ropes led over pulleys at the outboard end of the jib and thence secured to the racking barrel. The full load of 40 tons is racked backwards or forwards at the rate of 22ft. per minute and the smaller load of 7 tons at the rate of 45ft. per minute.

The jib and slewing table are supported upon a truck carried by thirty-two centrally flanged wheels arranged in four rows. There are eight wheels in each row and the crane travels on two distinct pairs of double rails. The local gauge of each set of eight wheels is 4ft. 8½in., and the distance from centre to centre of each pair of double rails is 30ft. The whole crane, when carrying its load of 40 tons, can be propelled at the rate of 42ft. per minute.

The load is lowered by means of Matthews' hydraulic brake fitted with Peters' patented free wheel, which is claimed to ensure the most delicate control of the heaviest loads. All the motions are driven by a pair of engines having cylinders 11in. in diameter and 18in. stroke, supplied with steam at a pressure of 100 lb. per square inch by a vertical Hopwood boiler 4ft. 6in. in diameter and 10ft. 3in. high. As will be seen from the drawing, the operating gear is brought to a convenient position on a platform behind the centre of the crane. It is so arranged that there is a clear view of the load and of the machinery.

A large counterbalance box is fixed at the short end of the cantilever jib, and is filled with approximately 100 tons of pig iron.

The crane, which is, we believe, the largest travelling crane of its type ever built in this country, was satisfactorily tested after its erection in the makers' yard at Bath with a load of 50 tons.

## DOCKYARD NOTES.

H.M.S. LANDRAIL, the fourth torpedo-boat destroyer of the 1912–1913 programme, built by Yarrow and Co., Limited, of Glasgow, was handed over to the British Admiralty on the 10th instant. This vessel, which is 260ft. long and 27ft. 6in. beam, is propelled by turbines, the steam being supplied by three of Messrs. Yarrow's latest type of water-tube boilers, fitted with feed heating and superheating arrangements. H.M.S. Miranda, which is also being built by Yarrow and Co., Limited, has been successfully launched at the firm's yard. This vessel, 260ft. long by 25ft. 7in. beam, is one of the three special torpedo-boat destroyers ordered from Yarrow and Co., Limited, of their own design. The contract speed is 35 knots. The vessel is, like the Landrail, fitted with the firm's latest type of water-tube boilers and superheaters.

THE new Turkish sea-going torpedo boats which have been ordered from Normand, of Havre, will be of 1040 tons displacement, 287ft. long, fitted with Parsons turbines developing 22,000 horse-power, and a speed of 32 knots. The armament will consist of five 4in. guns and six 21in. tubes.

## LETTERS TO THE EDITOR.

*(We do not hold ourselves responsible for the opinions of our Correspondents.)*

### SURFACE COMBUSTION.

SIR,—May I trespass further on your space to deal with important matters arising out of Mr. Daman's interesting letter in your issue of last Friday ?

I have made so large a number of gas calculations that the tabulated results would easily fill a whole issue of your valuable journal. These I have found to stand well the test of comparison with practical results. I have also checked such thousands of figures given in text-books, &c., that I find myself in the position to warn your readers to be careful in placing too much confidence in them.

When "doctors differ" it is awkward ; when they are misrepresented in bad faith it is serious ; but when they are misquoted in good faith by *people of repute* the result is appalling. I am reluctantly impelled to suspect Mr. Daman of having furnished a bad example of the last case.

In the literature I have discovered innumerable cases of careless mistakes on the part of gifted authors and printers' devils; *e.g.*, on one page alone of one of the best books, 0.1718 for 0.1781, and $t' + t'$ for $t' - t'$. Further, I find cumulative errors due to the pernicious and lazy way of trying to avoid dealing with the full number of places of decimals. Where, as in gas calculations, small numbers are multiplied by the squares of large ones, running into millions, the cutting of decimals leads to very serious error. Personally using logarithms, little trouble is saved thereby, and I never dispense with a single place of decimals in any stage of my calculations, merely docking the final ones in the final result.

Further, I find chaos often to exist owing to confounding mean specific heats with *relative mean specific heats*. This being of such vital importance, I deal with it at length.

The true mean specific heat of a gas is usually expressed by the formula $a + b(273 + t)$, where $t$ is the temperature in degrees Centigrade.

This may be transposed into $a + 273\,b + b\,t$, or $(a + 273\,b) + b\,t$ ; the latter is the more usual and the more liable to result in erroneous application of the formula.

The heat-content or sensible heat of the gas is $(273 + t)$ times the foregoing, and is therefore $a(273 + t) + b(273^2 + 546\,t + t^2)$, from which the difference between the heat-contents at temperatures T and $t$ becomes :—$a(T - t) + b[546(T - t) + T^2 - t^2]$, and the above is divisible by $(T - t)$, yielding $a + b(546 + T + t)$, which is the *relative mean specific heat* between the temperatures $t$ and T.

Making $t = 0$, the *relative* mean specific heat at temperature T becomes $a + 546\,b + b\,T$, which is best written $A + b\,T$ where $A = a + 546\,b$.

*It is therefore always essential to know whether the first figure in a given formula derived from an authority is* $a + 273\,b$ or A. I have often found it difficult to arrive at this.

I generally use a table of specific heats given on the authority of Th. Beckert in Dichmann's treatise, the "Basic Open-hearth Process"—which I translated. From the way in which Dichmann uses them I have taken them as being *relative* mean specific heats, *i.e.*, $A + b\,t$. For 1 cubic metre gas these are :—

| | |
|---|---|
| Diatomic gases | $0.3073 + 0.0000384\,t$. |
| $CO_2$ | $0.3861 + 0.0002510\,t$. |
| $H_2O$ vapour | $0.3555 + 0.0002311\,t$. |

Dr. Kietaibl, in his excellent work, "Das Generatorgas," gives data on the authority of Le Chatelier. He states on that authority that with the exception of $CO_2$ and $H_2O$ the molecular heat of gases is the same. He gives the following figures for molecular heats :—

| | |
|---|---|
| Normal gases | $6.5 + 0.00006\,(273 + t)$. |
| $CO_2$ | $6.5 + 0.00037\,(273 + t)$. |
| $H_2O$ vapour | $6.5 + 0.00029\,(273 + t)$. |

On dividing these figures by the molecular volume, *i.e.*, 22.32 cubic metres, we obtain as purporting to be Le Chatelier's values :—

| | |
|---|---|
| Normal gases | $0.29857 + 0.00002682\,t$. |
| $CO_2$ | $0.33647 + 0.00016577\,t$. |
| $H_2O$ vapour | $0.32668 + 0.00012993\,t$. |

I repeat what Mr. Daman purports to be Le Chatelier's values :—

$0.303 + 0.000054\,t$.
$0.37 + 0.00044\,t$.
$0.34 + 0.00030\,t$.

Now, I favour Beckert, for it seems likely that the agreement in the molecular heat of gases should be limited to the diatomic gases.

As suggested by Mr. Daman, I have applied his data, interpreting them both ways, to the gas I had in view when I wrote my first letter. The results are as follows :—

*Calories Heat-content of Burnt Gas 0 deg. to t deg.*

| Temperature. | Beckert. | Daman I. | Daman II. |
|---|---|---|---|
| 1400 deg. | 4131.3 | 4390.4 | 4954.0 |
| 1500 deg. | 4515.8 | 4832.1 | 5435.9 |
| 1600 deg. | 4796.0 | 5298.0 | 5934.9 |

The actual calorific power of the gas ($H_2O$ as vapour) was ascertained at 4700 calories. Thus Beckert's data fix the limit of calorific intensity at a little under 1600 deg. and Mr. Daman's data at well under 1500 deg. and 1400 deg.

Now, I obtained just over 1500 deg. with this gas and failed to reach much more. I certainly require more than Mr. Daman's letter to upset my faith in Beckert. His data appear worse than useless, and do come under serious suspicion that they are not even what they purport to be. I have been so much perturbed, though, by innumerable errors that I feel that I must ferret out all matters *de novo* from the original sources.

The town gas alluded to was ordered to be specially re-analysed for me by the general manager of the very large gas company. The trials alluded to were undertaken by that gentleman, his expert staff, a managing director of a local steel works, and myself. As stated, the calorific value was actually ascertained and officially communicated to me. I think therefore that a slightly stubborn attitude on my part regarding that case is natural and excusable.

It seems to me that a specially designed Bonecourt furnace would be a most excellent apparatus to employ to check the values of specific heats at high temperatures. I should much like to learn of this being done.

As to the practical objections I had raised, I do not regard Mr. Daman's reply as quite as explicit as I should like it to be.

I naturally had taken the high temperatures stated to have been obtained as having been obtained under *working conditions*, and not as being accompanied by destruction of the heat radiating combustion surface, and I think this ought to have been clearly stated in the original articles. ALLEYNE REYNOLDS.

Heve, June 15th.

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SIR,—Will you afford us an opportunity of replying to the criticism of Mr. H. Cameron in so far as it deals with statements of fact in your recent articles on "Surface Combustion" based on figures supplied by us.

We notice, on reading Mr. Cameron's letter, that it is possible to draw an extremely misleading conclusion from a somewhat elliptical statement occurring in the last of the three articles. The statement in question relates to the evaporation produced by the combustion of solid fuel, and reads :—"The evaporation produced amounted to 17.8 lb. of water from and at 212 deg. Fah. per hour."

The ellipsis consists in the omission from the end of the sentence of the words "per square foot of heating surface." Mr. Cameron has taken the statement to apply to the evaporation produced per pound of fuel burned, whereas the intended meaning was as stated.

Replying further to Mr. Cameron, the fuel employed was coke, which was selected as being the most immediately available form of solid fuel of known composition at the time when the experiment was made.

Adverting to the test of the liquid fuel fired Bonecourt boiler, we desire to say that the steam produced during the trial was tested for priming and found to be technically dry. The calorific value of 17,800 B.Th.U's. is clearly stated in your article as being the net calorific value, and we may add that this figure was determined independently by a fuel analyst of high repute.

Having regard to the very careful manner in which the test was carried out, involving as it did an independent measurement of radiation loss, and a measurement of the heat lost to the system in the form of sensible heat carried by the flue gases, we do not think that any reasonable doubt can attach to the figure claimed for the efficiency of the plant, namely, 92.5 per cent.

As Mr. Cameron points out, 36 lb. of oil hourly per burner is not a large amount, and we have already taken steps in our new designs of Bonecourt oil-fired boilers to increase the consumption per burner very considerably. We have already burned over 300 lb. of oil hourly per burner in larger designs of unit, the combustion being quite as good as that recorded in the boiler test, as is shown by the following analysis of combustion products :—

| | |
|---|---|
| Carbon dioxide | 13.3 per cent. |
| Oxygen | 2.7 ,, |
| Carbon monoxide | 0.0 ,, |
| Nitrogen | 84.0 ,, |
| | 100.0 |

From experiments which we have carried out, we have f und it possible to burn 200 lb. of oil per hour for each cubic foot of vaporising chamber, as compared with the normal practice in marine water-tube boilers, burning 8 lb. to 10 lb. of oil per cubic foot of combustion space, this rate rising up to 18 lb. to 20 lb. under forced conditions of firing.

For BONECOURT SURFACE COMBUSTION, LIMITED,
C. W. DAMAN,
Secretary.

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### GREAT DISCOVERIES.

SIR,—This is a wonderful world ! It is a very wonderful world, and men have made many wonderful discoveries ! We heard the other day that someone had invented a new electric railway, and that trains are going to run, or rather fly, at 300 miles an hour. It is hardly safe now to say that anything is impossible, since science and engineering progress at a rapid pace ; but when reports such as this appear in papers it is not wise to make a fuss or get excited. It is better not to take notice—as you did, Sir. A man builds a toy railway on which he runs a toy train on known principles. He invites to see it a party of unscientific gentlemen, and shortly afterwards articles appear in newspapers about a new and wonderful discovery. Our existing systems of transit are doomed, our leading engineers have been asleep, and a man hitherto practically unknown springs into prominence. What is the effect ? People begin to talk an unusual amount of nonsense. Credit is bestowed upon someone who has no right to it, and recognised authorities on such matters sink into oblivion. As a transporter for light articles the Bachelet system may find a field of application. I do not say that the whole thing is absurd. What I do say is that its usefulness has been greatly exaggerated. Much has been made of the fact that the system eliminates friction, because the trains do not run on rails, but what about air resistance at 300 miles ? Naturally, it does not count !

Edison was once a great inventor, a man with a colossal brain. He is said to have invented electric light, the dynamo, the telephone, and a host of things he has had nothing whatever to do with. But Edison has lost his fame. Anyone who likes to take the trouble to rig up apparatus and perform some experiment not generally known to the public is now welcome to notoriety. Within engineering and scientific circles this causes amusement ; outside such circles it has a bad effect. We are all apt to underestimate other people's difficulties ; we are all apt to make mistakes. The daily papers do not specialise in any sense of the word. Their editors are expected to provide with great rapidity all kinds of news, and the errors they sometimes make are perhaps in a measure excusable. You cannot expect a man who can write a good description of a prize fight to describe an engine, and a man who can describe an engine cannot describe a prize fight. But when a man undertakes to deal with something he does not understand he ought to consult some recognised authority.

I have referred to but one example of journalistic misjudgment. There have been others far more serious. At times of calamity the Press has a great duty to perform. It has to put before the world very rapidly details of how the accident occurred and to say if possible how it might have been avoided, or how the results might have been rendered less disastrous. People, unfortunately, are far too ready to blame and condemn those in authority and to form all kinds of theories without properly understanding the facts of the case. Reporters in their haste to get together information accept almost any story that comes to them, and a hopeless muddle of conflicting statements frequently results. If a ship sinks the captain is criticised by people who have never been to sea, and who know no more about ships than ships know about them. If an accident occurs on a railway we hear of all sorts of wonderful inventions, and railway directors, managers, and engineers are severely reprimanded for not adopting them. At the time of the Aisgill disaster there was a great outcry because the train that came to grief was not fitted with electric light, but when the matter was properly investigated it did not seem that electric light would have made much difference.

A true inventor is a useful man, who ought to be well rewarded. A crank is a public nuisance, and ought to be put away in a home, and a journalist who cannot distinguish an inventor from cranks like these latter ought to seek the assistance of someone who can. If everyone who sets out to write took the trouble to learn something about the things they write upon it would be better for themselves, and far better for the remainder of the community.

We have not seen the last wonderful invention ! Many others are to come. But great changes do not take place suddenly. Knowledge is accumulated in instalments, like rain-water in a bucket, and if a man claims to have invented something that is going to revolutionise the existing order of things it is pretty safe to assume that it is of no particular importance.

June 17th. M. Y.

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### PERMUTIT WATER SOFTENING PLANT AT HOOTON, CHESHIRE.

SIR,—The description of the above in your issue of 12th is interesting as relating to the first plant on this system, for dealing with a public supply in this country—probably the first in any country.

In considering the suitability of such a system as compared with others already in use, two points appear of paramount importance, namely :—

(1) The suitability of the treated water for the purpose in view.

(2) Its cost as compared with other systems having the same end in view.

Taking point No. 2 first, the cost for 1000 gallons is given as 0.7d. The cost of salt alone is not given, but its quantity is stated, namely, 2 tons 17 cwt. per 12 hours—that is to say, per million gallons.

Two millions of gallons are treated every 24 hours, so that the total annual output is 730 millions, the hardness of which is reduced from 19 to 9, equal to a reduction of 10 grains per gallon. Allowing 0.2d. for labour and general charges, there remains an amount of 0.5d., which probably is about the right proportion of cost to charge for salt alone.

The yearly quantity of salt on the above basis works out at 2080 tons. 0.5d. per 1000 means salt at 15s. per ton on the above basis—surely lower than the market price for the vacuum salt employed.

At 15s. per ton the annual figure for salt works out at £1560.

Looking now at the cost for softening the water to the same extent with lime of 90 per cent. purity, a quantity of 0.9 lb. per 1000 gallons would suffice, equal to 8 cwt. and 4 lb. per million.

For the 730 annual millions 293 tons would therefore be required, which at the price of £1 per ton works out at £293.

Excess cost of salt as compared with lime £1267.

These figures show the cost for salt with the Permutit plant in this instance to be 5.3 times as great as would be the cost for lime if that method of treatment were employed.

Returning now to point No. 1, suitability of water for its purpose. In this respect, again, the balance is in favour of lime treatment, by which the total solids in solution in the water would be reduced, whereas the Permutit system actually adds slightly to them, as in lieu of the 10 deg. of lime removed there are substituted about 10.6 deg. of carbonate of soda, a form of chemical impurity which may be good for wool-washing, the purpose to which I understand the Permutit system was originally applied in Germany, but surely an undesirable addition to water for drinking purposes ; its troublesome effects in hot-water systems and steam boilers are well known.

*Simplicity.*—Had the lime system been employed, the iron would have been removed without additional apparatus, avoiding the special plant for the purpose which is a necessity with the Permutit system, as the presence of iron in the water supplied to the softening part of the Permutit plant would cause it to fail. It would therefore appear that as compared with the lime system the Permutit supplies water less suitable for its purpose, the cost of working it is many times greater, while the process in the above instance is more complicated to the extent of the separate iron separating apparatus. WILLIAM BOBY.

London, June 15th.

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### THE NORTHUMBRIAN.

SIR,—I was very pleased to read the letter from Mr. Knight, as no doubt you will well remember the heated discussion about this engine thirty-one years ago—and am sorry that Mr. V. Pendred is not with us now. The argument arose through Mr. Nasmyth sending a sketch to your paper saying it was the "Rocket" as she appeared at the Rainhill trials. It was then pointed out by the late J. Watt Boulton that the sketch was the "Northumbrian," and not the "Rocket."

Now, thirty-one years have passed by and many of those who took up the argument are also gone. Thanks are due to Mr. Knight that he has come forward with some proof that the first sketch of Nasmyth's was not the "Rocket." Many of the old Liverpool and Manchester locomotives came into our possession and were converted. The old engine that was used at the Manchester end of the line during the construction—a photo of which is reproduced and issued by the London and North-Western Railway (postcards)—was given to my father by one of the Stannards, who was an assistant to Stephenson during the construction of the line.

Cheadle, June 16th. JAMES WATT BOULTON.

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## THE RAILWAYMEN'S CONGRESS.

THE first annual general meeting of the National Union of Railwaymen opened on Monday at the Albert Hall, Swansea. Mr. A. Bellamy, the President, was in the chair, and delivered a presidential address which was remarkable for its moderation. He said that already the experiment of fusing their three separate trade union organisations into one great powerful central union had been justified. The new organisation had met with great success, a success which had confounded the sectionalists. Its appeal had met with a response phenomenal in the history of trade unionism. Those who were pessimistic as to the possibilities of organising railwaymen had been astounded. When the new union was launched in London fifteen months ago the membership of the three unions combined was close on 180,000, but their membership had now reached 300,000. He was still not satisfied, and should not be until the non-unionist had been eliminated from the railway service. The effect had not been confined to membership ; it had improved the *morale* of the men employed on railways and increased the power of the Union for useful work on behalf of its members. It had rendered the task of negotiating with the railway companies a much easier one, and the fact that they were at present engaged in hammering out a new scheme for the settlement of disputes and the adjustment of wage conditions with the representatives of the companies was conclusive proof of the wisdom of the step which had been taken in increasing the scope of the organisation. From that position it was not their intention to recede. So long as the Executive Committee had the support of the members and represented a majority of the men employed in the railway service they would claim the right to speak on their behalf and to negotiate direct with the railway companies. He fully recognised that increased power brought additional responsibility on members and officers alike. Mere bigness did not justify tyranny ; might was not right ; and the use of a large and powerful organisation must be exercised with discrimination and with common sense. The rules of the N.U.R. were framed on democratic lines, and upon them at that meeting was placed the responsibility of deciding its future policy. If that policy was to be carried out, and if that great union was to succeed, it could only be by the loyal adhesion to rules by the members and by the unswerving support of the Executive Committee which was elected to administer them. The protection of the members from injustice and the assistance of the union in improving their position, could only follow if there was a steady resistance of all anarchistic tendencies and a steady reliance upon those charged with the responsibility of conducting its affairs. A further step had recently been taken towards the creation of a still greater industrial combination. An alliance had been entered into with the miners and transport workers which constituted the largest and most formidable labour combination the world had ever seen. It was neither revolutionary nor Syndicalistic. It was a force that was not intended to be used indiscriminately or frivolously ; it was not to be used like "a steam hammer to crack a nut," but it was a solidifying movement for mutual co-operation in times of national emergency. It was for the Congress to approve or disapprove of their action. The near approach of the end of most of the agreements with the railway companies had led to the launching of a new programme. That programme was the result of careful consideration by their Committee. Suggestions were invited from all the branches, and the Committee had sought to embody in concrete form the greatest possible number of points on which there was the largest agreement. It was useless to attempt in a national movement a detailed programme for each grade. Such a course would defeat itself. The programme was at the same time simple and comprehensive. It sought the establishment of an eight-hour day to increase leisure, and by an increase of 5s. per week all round to add to the comfort and happiness of the men employed on the railways. It was for them to give those demands an emphatic, and, he trusted, a unanimous stimulus.

## THE MÜLLER CONDENSER.

A SYSTEM of extracting the air from the vacuum chambers of condensers which has been extensively adopted in Germany and on the Continent generally is illustrated herewith. It is the invention of Dr. P. H. Müller, of Hanover, and depends for its action on a water jet air ejector, the water used in the jet being the same as is used for cooling purposes on its way from the pump to the condenser. The illustrations, Figs. 1 and 2, show diagrammatically a surface condenser plant in which the water is lifted in the usual manner by means of a single-stage centrifugal pump A, and is forced under pressure through the air ejector B and condenser tubes. In the nozzle of the air ejector the pressure is transformed into velocity in a well-known manner, and the descending jet absorbs and carries with it the air and incondensible gases which it has drawn from out of the condenser chamber into the diffuser, and compresses them to atmospheric or, if necessary, a higher pressure. From the diffuser the air and water in intimate mixture enter the separating cone C, wherein the velocity of the mixture is sufficiently reduced to allow the air to separate, rise and escape into the open through the tube D, while the water, which has reacquired the necessary pressure, continues its course from the separating cone into and through the condenser, where it condenses the steam and becomes warmed in the process before being exhausted.

The air ejector may be worked in series or in parallel with the condenser. When worked in series the whole of the cold circulating water from the pump passes first through the ejector in which it forms the jet, and then through the condenser from which it is discharged as warm water, as shown in Fig. 2. When the separator cone is situated above the water level of the warm or discharge circulating water tank, and the return pipe from the condenser discharges into the tank below the water level, this return or discharge pipe forms a syphon and the pressure in the separator cone is lower than it would be were there no syphon. Where the difference in height between the separator cone and the water level in the tank is only slight, as in Fig. 2, the pressure in the separator cone, though reduced by the syphon effect, will still, owing to the resistance to be overcome by the circulating water in its passage into and through the condenser, be sufficient to ensure the free discharge of the separated air and incondensible gases through the vertical air tube. Where, however, the water level of the discharge circulating water tank is so much below the separator cone that the pressure in the latter is lower than that of the atmospheric pressure, and the air and gases cannot freely escape into the open, the air duct from the separator cone is connected to the discharge or syphon pipe from the condenser. Here the air and incondensable gases mix with the discharge water and are carried by it into the tank below at atmospheric pressure and are there liberated. When the air ejector and the condenser work in parallel a portion only of the cold circulating water from the centrifugal pump is used for the jet of the air ejector, and the bulk of the water supplied by the pump passes direct to the condenser tubes. After passing through the ejector, where it extracts and cools the air, the jet water passes through the diffuser and separator cone and returns to the suction pipe of the centrifugal pump, where it is used again. This method of working is advantageous when the discharge water tank is situated at a much higher level than the separator cone—for instance, when the condenser is connected to work with a re-cooling plant.

In such a case, with the plant shown in Fig. 2, the pressure in the separator cone would be excessive, impairing the efficiency of the ejector and increasing the power required to operate it. By operating the air ejector and condenser in parallel, however, the pressure in the separator cone will be at or about atmospheric, and only that portion of the cold pump supply requisite for the full discharge of the air from the vacuum chamber need be passed through the ejector nozzle. On the other hand, the main stream of cooling water can be raised to the pressure requisite to force it through the condenser tubes and to the height of the discharge tank or cooling tower without the necessity of considering the effect of such pressure on the operation of the air ejector and separator cone. The proportion of water to be by-passed from the main stream to the ejector for any given volume of air will, of course, depend on the pump pressure of the circulating water.

It will be observed that when working in series the Müller system requires a higher initial pump pressure for the circulating water in proportion with the work the latter has to do in the air ejector than is required in a condensing plant of equal capacity and efficiency without such air ejector, but the weight of water to be supplied by the pump is similar. On the other hand, when working in parallel the system requires a heavier pump supply than plants without the air ejector, but the pressures are the same in both.

As will be seen, the Müller condenser could scarcely be more simple, the only working mechanism being two centrifugal pumps, a large one for the cold circulating water and a small one to exhaust the water of condensation. Where a head of water sufficient for effective circulation is available the force pump may be dispensed with. In the vacuum chamber the steam flows in one single stream through and between the nest of tubes and at right angles to them, no baffle plates being required. Frictional resistance is thus reduced to a minimum. After the two pumps controlling the circulating water and the water of condensation have been started up and the water sluice valve has been opened, the condenser begins at once to exhaust, a 50 per cent. vacuum being obtained usually in two or three minutes from starting. In case of a sudden inrush of air, with the Müller condenser the only effect would be partially to destroy the vacuum. The supply of water to the jet would not be interfered with, and the air ejector would continue to work, dealing to the best of its capacity with the excess of air, but with inferior results, until the air leakage had been made good.

In the unlikely event of the failure of the centrifugal water pump the air ejector will cease to draw air from the vacuum chamber, and the suction pipe will be automatically closed by the valve E shown in section in Figs. 1 and 4, while the mixing chamber of the ejector will be automatically opened to the atmosphere preventing cold water from entering the vacuum chamber.

A further advantage claimed for the system is that the air is reduced to the temperature and to the volume corresponding to such temperature of the cold water ejector jet by which the air is drawn from the vacuum chamber. This is an important factor with regard both to the efficiency of the condenser and the power required to effect the exhaustion of the air. Again, as regards light loads, the usual practice is to reduce the output of circulating water, and consequently the pump power required. In the Müller condenser the full load supply of circulating water is maintained and the vacuum is improved on the light load, with the result that the higher efficiency gained

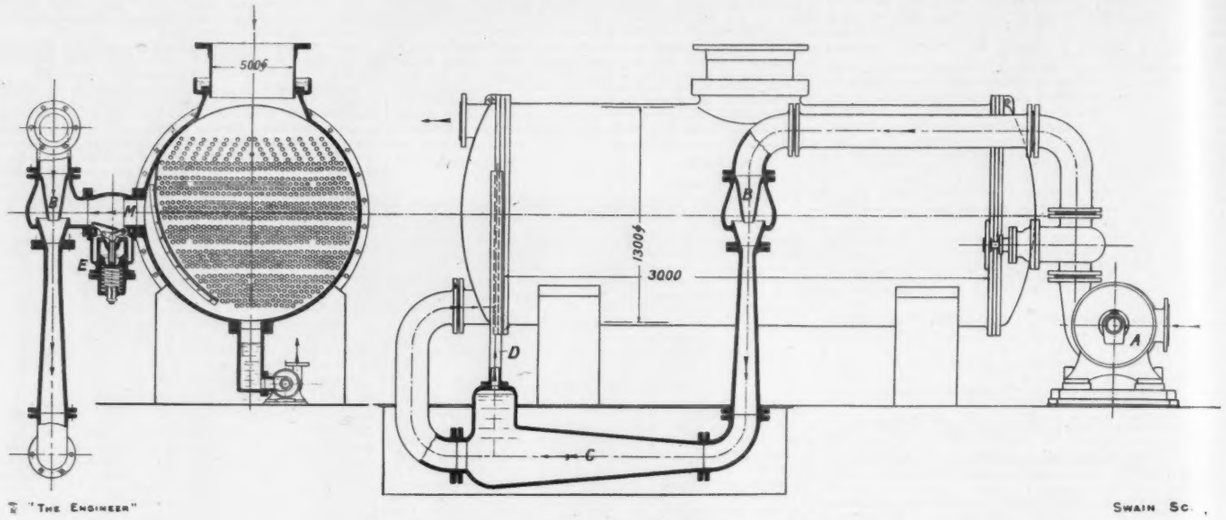



Fig. 1—ARRANGEMENT OF THE MÜLLER CONDENSER

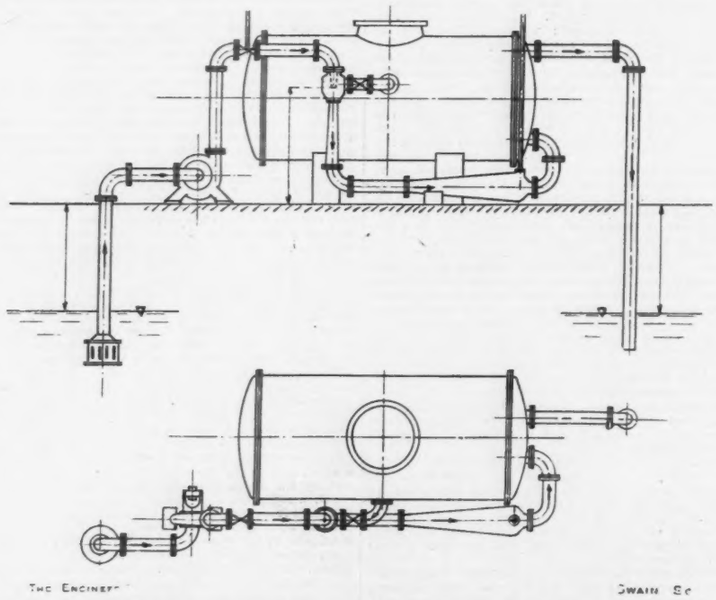



Fig. 2—THE MÜLLER CONDENSER ARRANGED IN SERIES

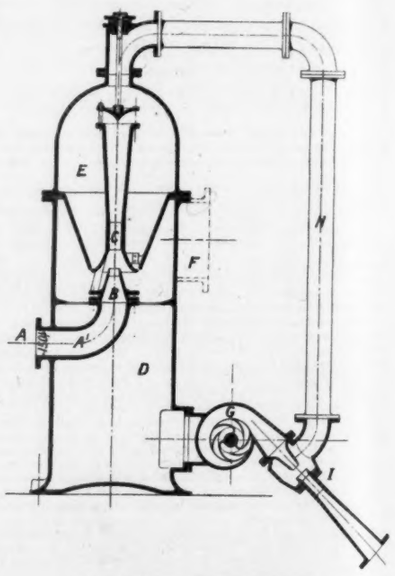



Fig. 3—MÜLLER JET CONDENSER

in the steam turbine compensates for the comparatively higher pump power developed.

The safety valve E above referred to is shown drawn to a larger scale in Fig. 4. Its action is as follows:—When the flap valve *a* is open so as to uncover the port *b* of the casing *c*, the air can pass into the mixing chamber of the ejector without altering the direction of flow. The flap valve is mounted on a lever *d* pivoted at *e*, and is actuated by the stem *f* of the piston, which slides in the cylinder *h*. The space above the piston is connected with the pressure water space of the ejector, either directly by the pipe *i* or by an auxiliary controlling device, as shown at the foot of the illustration. When the space is connected direct to the pressure chamber of the ejector the space below the piston is open to the atmosphere either direct or through the agency of a valve *k*. The action of the apparatus is as follows:—If there is no pressure in the pressure chamber of the ejector there will be no pressure in the space *l* above the piston. The spring *p* keeps the piston in its uppermost position, and the flap *a* closes the port *b*; but when there is a sufficiently high pressure in the chamber of the ejector the piston *g* is forced down against the action of the spring. The flap valve *a*—shown in a half-open position—will then open fully by gravity if there is no vacuum in the condenser. Should there be sufficient vacuum, the flap valve will be kept up against its seat by the atmospheric pressure on the other side. The piston will, however, descend, and as soon as the vacuum is restored by the action of the ejector on the left-hand side of the flap valve, the valve will open automatically. In order to admit air automatically into the mixing space of the ejector, as soon as the flap valve *a* is closed the piston uncovers the annular port *q* in the cylinder wall *h*, and air is allowed to pass from the space below the piston through the passages *m* into the casing *c*, and from there into the mixing chamber of the ejector. It will be seen that double security is provided against the flooding of the condenser, as the air pipe M—see also Fig. 1—is automatically closed,

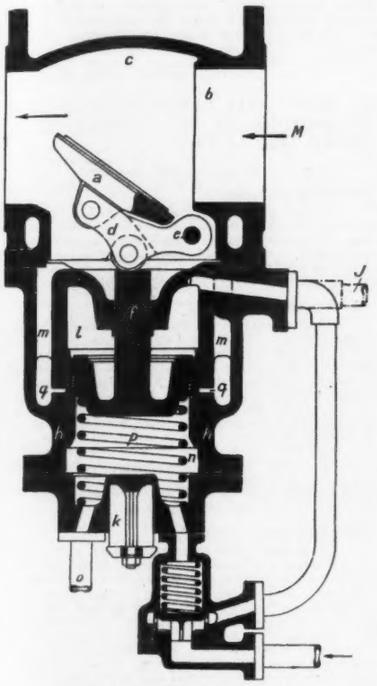



Fig. 4—AUTOMATIC VALVE

and at the same time the vacuum in the mixing chamber of the ejector is destroyed by establishing a connection with the atmosphere as soon as the pressure in the pressure chamber of the ejector is insufficient for its work. The space *n* below the piston is closed to the atmosphere by the valve *k*, and the pipe *o* connects the space *n* with the discharge pipe of the ejector. When the discharge pipe of the ejector is obstructed, therefore the pressure in the spaces above and below the piston is the same, and the flap valve will be prevented from opening and admitting water to the vacuum space of the condenser. When the ejector is working properly and the vacuum raises the piston, the valve *k* below the piston is also lifted, allowing the air to enter the space *n*, whence it passes through the ports *q* and passages *m* by way of the casing *c* to the mixing space of the ejector. An auxiliary controlling device is shown at the bottom right-hand corner of Fig. 4, the object of which is to cause the piston *g* to perform at once the whole stroke as soon as the water in the ejector falls below a certain pressure.

A sectional view of the Müller jet condenser is given in Fig. 3. As will be seen, this is equally as simple in construction as the surface condenser. At starting up the condenser chamber being open to the cold water supply at the branch A, a vacuum is produced in the chamber by means of an auxiliary steam ejector or exhauster and cold water is drawn by suction through the branch $A^1$ into the condenser. The vacuum and water circulation having been established, the centrifugal pump G is started, and the steam ejector shut off. The condenser will then continue to operate without further attention. The jet of cold water rising from the supply pipe through the nozzle B draws with it the air and incondensible gases liberated in the vacuum chamber D, and carries them through the combining cone C, wherein they are slightly compressed into the upper chamber E. As a consequence, the absolute pressure is higher in this chamber than in the lower condenser chamber, and the water, which is maintained at a given level, flows in sheets from the upper chamber through the radial openings at the bottom of the inverted cone into the lower part D, wherein it meets and condenses the exhaust steam from the engine which enters by the branch F. The water of condensation falls into the hotwell and is discharged by means of the centrifugal pump G. The released air and incondensible gases are drawn through the cold water jet B and are exhausted at their lowest temperature and volume through the pipe H by means of the second ejector I. This is operated by the hotwell or warm water discharge under pressure produced by the pump G. In the combining cone of this second ejector the air and gases are compressed to the pressure of the atmosphere before being exhausted into the open. The water level in the upper chamber E is governed by an external water gauge and adjustment of the radial clearances, while an automatic vacuum breaker is provided which on the failure of the centrifugal pump immediately operates to stop the inrush of cold water.

The following data of tests of Müller plants which have been carried out at power stations on the Continent have been supplied to us by the inventor, and speak for themselves:—

| | Achern (Baden). | Norddeutsche Hütte (Bremen). | Gummersbach (Diferinghausen). |
|---|---|---|---|
| Normal load, kilowatts | 1500 | 2000 | 5000 |
| Temperature of circulating water at pump, deg. Fah. | 77.2 | 46.4 | 41 |
| Temperature of circulating water at exhaust, deg. Fah. | 83.3 | 59 | 51 |
| Temperature of condensed steam, deg. Fah. | 86.0 | 63 | 54.5 |
| Vacuum, per cent. | 95.7 | 98 | 98.53 |
| Vacuum per cent. of theoretically possible | 99.6 | 99.75 | 99.85 |

The licensees for the construction of this condenser in the United Kingdom are Willans and Robinson, Limited, Musgraves, Bolton, and D. Adamson and Co.

## FAMOUS ENGLISH RAILWAY ADMINISTRATORS.

THE appointment of an American general manager for the Great Eastern Railway, or, rather, the reason advanced for making it, has naturally drawn attention to the different plan of railway administration followed in England and America respectively. These differences will be familiar to the readers of this paper, and need not be recapitulated. Nor need they be criticised, as it may be taken for granted that England and the United States have each developed an administrative system best suited to its individual requirements. The position of general manager of an important British railway is one of immense importance. To be successful the man must be of vigorous intellect and active habits, and should combine great firmness of purpose and perseverance with the grace of a conciliatory spirit. He must be skilled in devolving the execution of his ideas upon others, and resolute not to be drawn into dealing personally with details. The conflicting interests of many districts and industries have to be smoothed out; schemes must be carefully coached through Parliament; hence, the saying that "every general manager becomes half a lawyer;" the inventions of science need examination; and a mass of economic problems call for solution. Lastly, from sharing with the secretary and solicitor the custodianship of the company's policy for many years ahead the general manager must be reticent and cautious in his public utterances.

In early days ex-officers of the Navy and Army were preferred for the post, on the grounds that maintenance of discipline was the principal thing needful. It was soon realised, however, that the general manager should have had a practical, but not necessarily technical, railway training. Many of the most successful managers have risen from the lowest rungs of the ladder; the majority ascending through a commercial department, like the goods; some through the traffic, and some through the engineering; while there is a modern tendency to appoint the company's lawyer. But while, broadly speaking, the directors do not interfere with the general manager's discharge of executive details, there have been chairmen whose knowledge, energy, and enthusiasm led to their taking much of this upon themselves. Such chairmen have been almost invariably practical railway men, and sometimes have acted as general managers of the lines prior to their elevation to the boards. On the other hand, we more frequently come across general managers who have ruled the board, compelling it to adopt views which they themselves originated.

The general managers of our great railways are seldom long-lived. So absorbing and exacting are the demands, that only those of abnormal vital powers survive the strain. Seventy is not old for a judge or a bishop, but few railway managers live to that age, as they are prematurely aged or broken in health by the constant strain of the work, with its long and irregular hours. The death of Sir Frank Ree is the latest addition to the long list of those who have succumbed at the age of sixty or thereabouts. Still, there have been notable cases of longevity, as will be seen.

At the present juncture the careers of our most eminent railway administrators in the past may be recalled. Captain Mark Huish was our first great railway administrator, and one of the most remarkable of any age. He entered the military service of the E.I.C. at an early age, but, resigning his commission shortly after the beginning of the railway period, he became secretary and general manager of the Glasgow and Greenock Railway in 1840. Here his activity and powers of rapid organisation and discipline soon attracted attention. When the Liverpool and Manchester and Grand Junction systems amalgamated he was offered and accepted the post of general manager. The fusion of the Grand Junction and London and Birmingham Railways in 1846, under the title of the "London and North-Western Railway," was in a great measure due to him. He became the first general manager of the amalgamated concern, and the foremost public authority in railway management. Captain Huish's rule was most arbitrary, but it was based upon sound commercial principles as well as upon an admirable system of centralisation. He enforced the utmost responsibility everywhere, and succeeded by this and other means in securing a regularity, safety, and celerity in railway travelling, together with a command over sudden and overwhelming irruptions of traffic, never known before. His management of the unprecedented exhibition traffic in 1851 was a wonderful achievement for these days. In 1852 he pre sented to the Institution of Civil Engineers a suggestive paper on railway accidents, in which he invented the familiar term "rolling stock."

Huish's fame mainly rests, however, upon his policy of drawing the principal northern lines into a confederacy with Euston-square as its base. For more than a decade he successfully pursued the creation of the most wide-spreading combination ever known in the annals of British railways. With consummate skill he played off rival companies against one another, and when diplomacy failed he set up "junction barriers," in the shape of such annoyances as misfitting connections, running powers rendered a dead letter, &c., while in the last resort he had recourse to a system of downright terrorism, as, for example, at Chester and Manchester, where he forcibly ejected booking clerks from their offices, destroyed tickets and advertisements, set up barricades to prevent omnibuses entering the station precincts, tore up the rails, tampered with signals, and procured the arrest of travellers arriving by the rival line as trespassers.

In 1852 Captain Huish was within an ace of bringing off his most ambitious coup, an absolute and entire fusion of the North-Western and Great Western Companies, the effect of which would have been to hand the nation over to a railway monopoly. The "Euston-square Confederacy" was eventually broken up, partly by legislation which declared Captain Huish's secret agreements to be *ultra vires*, and partly by the action of one of his disciples, Mr., afterwards Sir Edward Watkin, who, as manager of the Sheffield Company, concluded behind his back in 1857 the famous "Fifty Years' Agreement" with the Great Northern. Nothing then remained of the elaborate edifice which the North-Western manager had so laboriously built up, and in the following year he resigned his post to become deputy chairman of the Electric Telegraph Company. On his retirement he was presented with an address and handsome testimonial from upwards of 5000 North-Western servants, "from the humblest workman on the line."

Captain Huish died on January 18th, 1867, at his Isle of Wight home. It is curious that while his tombstone records his former service in the Bombay Infantry, there is not a word about his important career with the greatest of English railways. It is also a pity that no memoir of this remarkable railway administrator, whose name was once in everybody's mouth, was included in the "Dictionary of National Biography."

Only four years intervened between Captain Huish's resignation and the North-Western being again dominated by another great railway personality in Mr. Richard Moon. The latter began his career in the service of the Grand Junction Railway. He joined the North-Western board in 1847 and was appointed chairman in 1862, which position he held for twenty-nine years, and during that period the history of the undertaking was the history of his active and laborious life Moon's ideal was to make the North-Western the best railway in the world, but he entertained no dreams of a railway empire with its capital at Euston; rather, he cold-shouldered alliances of any sort. "The New York Central was not more absolutely the creation of Commodore Vanderbilt than the North-Western of to-day is the embodiment of the energy and foresight of Sir Richard Moon"—he was created a baronet for his services in 1887—wrote *The Times* on his retirement. When he was not at Euston in consultation with his officers he was more often than not somewhere down the line watching how things were going on. It was no unusual thing for him to be hard at work with the engineers over plans and estimates till after midnight, and then off at seven the next morning to consider the question on the ground. In his seventy-seventh year he was seen climbing ladders on the new Stockport Viaduct to examine the progress of the works. If there was anything that escaped his attention his officers, at least, never found it out.

Many stories were told of Moon's autocratic behaviour towards the staff, and even towards his directors. "Never let me see that man's face again!" was the sentence he pronounced on a clerk, who came to the office on a Saturday morning in summer, attired in flannel trousers. To a director who brought a newspaper into the board-room he severely remarked: "It is not the custom at Euston to read newspapers at board meetings. John," turning to a servant, "take away Mr. ———'s paper." If he heard a porter mispronounce the name of a station he would call the man to his carriage and correct him. At one period this autocratic chairman could not brook the existence of a general manager. In 1874 Mr. Cawkell resigned the active management of the line, and Mr., afterwards Sir, George Findlay succeeded him, but with much curtailed powers and duties, and the title of "chief traffic manager." Six years later the post of general manager was restored, and Findlay occupied it until his death in harness in 1893 at the age of sixty-three. Moon and Findlay thoroughly understood one another, and these two strong men formed an irresistible combination. Nothing ever distracted them from the regular and noiseless promotion of North-Western interests.

In his later years Sir Richard Moon was not easily convinced of the merits of any improvements which did not emanate from a member of his staff, and his great force of character led to his assuming and maintaining a predominance, which could not permanently be retained with advantage to the interest of British railways. Among the questions on which he entertained no doubt whatever was that it was not desirable for the North-Western to cultivate suburban traffic. This policy his successors did not seriously set about reversing until 1907, when the still uncompleted scheme of an electric railway to Watford was promulgated. Sir Richard died in 1899, in his eighty-sixth year. His life story forms another notable omission from the "Dictionary of National Biography;" but that of his able lieutenant, Sir George Findlay, who was offered the chairmanship on his retirement, but preferred to remain general manager, is included, mainly on the strength, we surmise, of the authorship of that valuable treatise, "The Working and Management of an English Railway."

In the "eighteen-sixties" the Great Western Railway was not the immense, wealthy, well-organised, and enterprising undertaking it has now been for some years. The system was then a comparatively small one, while the "wide" gauge fiasco had not only crippled its finances, but isolated it from healthy competition and improving intercourse with the other railway systems of the country. In 1863 Mr. James Grierson was appointed general manager, but without the assistance of a practical railwayman at the head of affairs he was unable to stay the rot. In 1865 the company reached the lowest ebb of its fortunes. The selling price of its shares sank to 38½, and a receivership seemed imminent. At this crisis the celebrated locomotive engineer, Sir Daniel Gooch, who had left Swindon to superintend the establishment of telegraphic communication between England and America, was invited to take over the chairmanship.

Under the Gooch-Grierson *régime* the Great Western Railway was metamorphosised. From being a comparatively small undertaking it became the largest as regards mileage in the kingdom, while the price of its shares rose to 160. Mr. Grierson, whose great work on railway rates is a classic, died at his post in 1893 at the age of sixty. Without the splendid foundation laid in the face of tremendous difficulties over a period of nearly thirty years by the above pair, the subsequent more brilliant—from the popular standpoint—era of Great Western history would have been impossible. The final consolidation of the system, together with its present reputation as a provider of appreciated travel facilities—corridor trains, rail motor cars, road motor services, long-distance non-stop runs, &c.—were almost wholly brought about under the chairmanship of the late Lord Cawdor, who was singularly fortunate in his succession of general managers, Sir Joseph Wilkinson and Sir James Inglis. Both of the latter died in harness at the age of sixty.

The death of Sir James Allport in 1892 snapped the last link between the primitive railways and the modern. He was twenty-eight years old when he entered the service of the Birmingham and Derby Railway in 1839 as chief clerk, from which he speedily rose to be "carrying manager." When the Midland Company was formed in 1844 Allport's services were dispensed with, and Hudson found him a place on the Newcastle and Darlington, where he put the finishing touches to piecing up the East Coast route, "the desert line by Berwick." From 1850 to 1853 Allport was employed by the Sheffield Company. He then returned to the Midland as general manager, and held that post till 1880, except between 1857–9, when he acted as managing director of the shipbuilding firm of Palmer, but, at the same time, was a director of the Midland. It was during these twenty-seven years that the Midland grew from a provincial line into one of the chief railway systems.

It has been said that what Rowland Hill did for the Post Allport did for railway passengers. The modern era of travelling began in 1872, when Allport introduced the practice of admitting third class to the best trains. He was a firm believer from the first in the eventual success of a course regarded at the time by most railway managers and shareholders as revolutionary, and it is written of him that "in after life he looked back on the improvement of the third class passengers' lot as the most satisfactory episode in his career." His importation of Pullman cars led to a remarkable improvement in British coaching stock, and he was mainly instrumental in popularising sleeping and restaurant cars in this country. In 1880 he retired from active management of the line on account of failing health, but remained an industrious member of the board down to his death. *The Times'* obituary stated that "during his last years he occupied himself in collecting and arranging the documents and reminiscences of his long and varied career," but, alas! they have never been published.

Sir Edward Watkin played a leading *rôle* in the arena of railway politics during the second half of the preceding century, and he was perhaps better known to the general public than any other railway administrator in the country. But, notwithstanding his vast experience and reputation the actual practical working of a railway was a subject he never studied and never really understood. Watkin was appointed secretary of the Trent Valley line in 1845, and on its absorption by the North-Western in 1846 he was "taken over with the rolling stock." After spending eight years at Euston he was transferred to the Sheffield Company as Captain Huish's nominee, where he attained the position of general manager, and eventually became chairman. It was his intrigues against his old master that primarily contributed towards the overthrow of the Euston-square confederacy, and earned for the Sheffield Company the name of the "railway flirt." He was made chairman of the South-Eastern Railway in 1867, and during his career he was a director of several other railways.

Sir Edward is, however, best remembered for his advocacy of the Channel Tunnel scheme. He was obsessed with the idea of forming a continuous route between Lancashire and France *via* Dover, and as part and parcel of that project he succeeded in transforming the Sheffield from an East and West line into a trunk artery. The "Railway Macchiavelli," as an opponent once styled the active baronet, had always many irons of all shapes and sizes in the fire. He had a scheme for the union of the Welsh railways, for an Anglo-Irish submarine tunnel, for a ship canal from Dublin to Galway, and for a replica of the Eiffel Tower at Wembley. Lastly, Sir Edward Watkin, with his frequent special trains, his banquets in the experimental bore for the Channel Tunnel, and his exploitation of Mr. Gladstone's political railway journeys, introduced a certain element of flamboyant American publicity methods into British railway life.

Within the first ten years of its existence the Great Northern became one of the leading railways, owing to its first chairman, Mr. Denison, and its second general manager, Mr. Seymour Clarke, pursuing this object with devoted singleness of purpose. "Thirty-five years ago," said Lord Claud Hamilton, "the staff of the Great Northern Company was considered in position, station, and ability second to none in the kingdom." That is true, and it was due to the late Sir Henry Oakley's methods. Sir Henry served sixty years with the Great Northern Railway, being general manager from 1870 to 1898, after which he was elected a director. Sir Henry died in 1912, in his ninetieth year.

The Great Eastern Railway will ever be under a debt of gratitude to Mr. C. H. Parkes, who assumed control in 1872, and continued to hold the chairmanship for more than twenty years. Very early in his career he obliterated its legacy of notoriety from the old Eastern Counties, carried out the invaluable extension to Liverpool-street, and gave the company the premier position for punctuality of all lines running into London. Mr. Parkes' name is commemorated in Parkeston Quay, Harwich, which established the success of the Great Eastern's continental services.

Lastly, mention must be made of Sir Charles Scotter's great work on the London and South-Western. Beginning his career on the Sheffield system, where he earned rapid promotion, Scotter was appointed to the general managership of the South-Western in 1884, a position he held with such conspicuous success that on his laying down the reins of office twelve years later he had the satisfaction of seeing the company's ordinary stock quoted at nearly double the price at which it had stood on his appointment. In the early "eighties" the South-Western was neither prosperous nor popular. His tenure of office witnessed the improvement of the rolling stock and the general accommodation, the provision of much faster and more liberal train services, and the creation of fresh branches of revenue.

The most notable achievement of his managership was unquestionably the acquisition by the company of the Southampton Docks, which, from neglect and obscurity, have advanced to be amongst the best-managed and most successful in the world. On his resignation his services were of too valuable a nature to be lost, and as director, deputy chairman, and finally chairman he continued to exercise control on the policy of a railway which, under his administration, rose from a struggling, second-rate concern to take its place amongst the prosperous main trunk lines of the country. His baronetcy was conferred on him in 1907.

No other men are more worthy of honours in the gift of the Crown than our railway administrators. Mr. George Glyn, the first chairman of the London and North-Western, was raised to the peerage in 1869, five years after he had relinquished that post. This distinction was, however, conferred on him more on account of his services as a banker than as a railway administrator. Nevertheless, he was prouder of the latter, and, in order to emphasise this, he took the title of Baron Wolverton, a town practically created by the North-Western's engine and carriage works, although he had no property in or near it. The first railwayman to receive a title for his railway services alone was Sir James Allport, whose knighthood, conferred in 1884, was described as being "in acknowledgment of the enlightened spirit with which he had administered the powers entrusted to him as a railway manager, and of the great benefits which the public have derived from it." Sir Daniel Gooch was not, as generally supposed, the first railway baronet, for his baronetcy was the reward for his share in laying the first successful Atlantic cable. This distinction belonged to Sir Richard Moon. The first general manager to be knighted while in active discharge of his duties was Sir Myles Fenton, of the South-Eastern Railway, in 1889. Knighthoods are now generally awarded to the general managers of the leading railways.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

MESSRS. STIGLER, continental lift and elevator manufacturers, have arranged with Mr. Thomas W. How, M.I. Mech. E., to represent their interests in Great Britain, with offices at No. 17, Victoria-street, Westminster.

MORRIS AND LISTER, Limited, of 3 and 4, Palace Chambers, Bridge-street, Westminster, S.W., and Carlton Works, Lockhurst-lane, Coventry, who have hitherto been representing Nalder Brothers and Thompson, Limited, to a limited extent for the sale of the latter firm's manufactures, have now been appointed its representatives in the London and country districts heretofore worked by Messrs. Frampton and Paine, whose agreement for the agency has now expired.

BRITAIN AND SIBERIAN TRADE.—It has been frequently said in these columns, as in others, that Great Britain takes but a half-hearted interest in the commercial development of Siberia, and we learn therefore with pleasure that a company called the British Engineering Company of Siberia, Limited, Central House, Kingsway, has been established to encourage trade between British engineers and Siberian consumers. The company does not work on the lines of the British Engineers' Association; it is purely a trading concern, and is, as we understand it, an "agency" on a very large scale. It is not limited in any way to the number of firms it represents or as to the lines of trade which it looks after, but it represents only one firm in each line of business. We are informed that it is already acting for about sixty firms.

THE ROYAL SANITARY INSTITUTE.—The twenty-ninth Congress of the Royal Sanitary Institute will be held in Blackpool from July 6th to 11th next. The following programme has been prepared:—On Monday, July 6th, at 1 p.m., there will be a reception of the members and delegates, in the Hotel Metropole, by the Mayor of Blackpool, followed by a public luncheon in the Hotel Metropole. At 3.15 p.m. the opening meeting of the Congress will be held in the Grand Theatre, and will be presided over by the Earl of Derby. On the Tuesday, at 10 a.m., there will be meetings of Section A, Sanitary Science and Preventive Medicine, in the Secondary School, and conferences of representatives of sanitary authorities and of engineers and surveyors, in the Secondary School. Marine excursions to Southport and Piel Island and motor excursions will occupy the afternoon. On the Wednesday, at 10 a.m., there will be meetings of Sections A, Sanitary Science and Preventive Medicine; C, Domestic Hygiene; and a conference of veterinary inspectors in the Secondary School. There will also be an excursion to Preston—cotton mills and electric works—and a visit to Fleetwood—sewage pumping station, ice factory, trawlers, curing-houses, and fish market—while at 8 p.m. there will be a conversazione and reception, at the invitation of the Mayor. On the Thursday, at 10 a.m., there will be meetings of Section B, Engineering and Architecture, and conferences of medical officers of health and sanitary inspectors in the Secondary School, and in the afternoon a garden party at Rossall School, by invitation of the head master and council, and various excursions. On the Friday, at 10 a.m., there will be meetings of Sections B, Engineering and Architecture; D, Hygiene of Infancy and Childhood, in the Secondary School; conference of port sanitary authorities in the Secondary School; and the closing meeting will be held in the Secondary School at 1 p.m. There will be excursions in the afternoon and the congress dinner will be held at 7.30 p.m. On the Saturday excursions will be made to the Lake District and Douglas, Isle of Man.

## FORTHCOMING ENGAGEMENTS.

### SATURDAY, JUNE 20TH.

PHYSICAL SOCIETY OF LONDON.—Visit to the Cavendish Laboratory, Cambridge. The directors of the Cambridge Scientific Instrument Company have invited the Society to visit their works. Leave Liverpool-street Station for Cambridge, 9.10 a.m.; travel by special motor omnibuses to the works of the Cambridge Scientific Instrument Company, arriving at 11.10 a.m.; visit to colleges, &c., 2 p.m.; visit to Cavendish Laboratory, 3 p.m.; tea by invitation of Lady and Sir J. J. Thomson, 4.30 p.m.; meeting of the Society in the Cavendish Laboratory, 5 p.m.

### SATURDAY, JUNE 27TH.

THE INSTITUTION OF MUNICIPAL ENGINEERS: EASTERN AND NORTH-EASTERN DISTRICTS.—12.45 p.m., assemble at Leicester (Midland) railway station, and proceed by conveyances on a visit of inspection to the Enderby and Stoney Stanton granite quarries. Arrangements will be made for blasting operations to be seen.

### TUESDAY, JUNE 23RD.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Summer meeting, to be held at the Imperial Hotel, London, W.C. Paper by Mr. C. H. Avery on "Some Experiments on the Loss of Heat from Buildings," with discussion. Topical question raised by the President, "Foaming in a Steam Boiler." Report re research work. 9.30 a.m.

### THURSDAY, JULY 2ND.

THE INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. The annual conversazione will be held at the Institution from 8.30 to 11.30 o'clock.

### FRIDAY AND SATURDAY, JULY 3RD AND 4TH.

THE INSTITUTION OF MUNICIPAL ENGINEERS.—North-Western District meeting. Friday: General Council meeting, tea and social meeting to be held at the Mitre Hotel, Manchester. Saturday: Visit to the Ashton-under-Lyne, Stalybridge and Dukinfield waterworks.

### WEDNESDAY, JULY 8TH.

DIESEL ENGINE USERS' ASSOCIATION.—At the Institution of Electrical Engineers, Victoria Embankment, W.C. 4 p.m. There will be no meeting of the Association in the month of August.

## THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

*(From our own Correspondent.)*

### Iron Trade Quietude.

THERE is not more than three to four days' work a week being done at the finished ironworks in South Staffordshire at date. On every hand the situation is being met by a restriction of output, prices generally having fallen so low that there is no room for further cutting. A few ironmasters are still comparatively well off, but they are a rapidly thinning minority.

### Bar Iron and Low Prices.

The bar iron trade shows no further decline, but business all round is slow. The £8 10s. basis still rules for marked bars, which is a comparatively high price. Bars from the North Staffordshire districts are nominally £7 5s., but it is stated that £7 is not refused for a good offer. Reliable second-class qualities of South Staffordshire bars make £6 10s. as a minimum, and go on up to £6 12s. 6d. per ton. There is still keen international competition for the common bar trade, but district makers seem to be holding their own. Belgian prices fluctuate a good deal, but, putting the basis as low as £5 7s. 6d. net, it is found that consumers often prefer the home production at £6 2s. 6d., less 2½ per cent., the conditions involving much less anxiety. Some business is done in South Staffordshire common bars at £6 5s. Hoops keep at £7 5s. and gas strip £6 5s.

### Galvanised Sheet Trade.

Sluggishness still characterises the galvanised sheet trade. Hesitancy is shown in placing orders for shipment. The exports last month were 54,397 tons, as compared with 70,238 tons. Some makers are still quoting £11 f.o.b. Liverpool for 24-gauge corrugated sheets, protesting that they cannot be made to show a profit at anything less, but orders are being taken freely by other manufacturers on the basis of £10 15s., and even less money has not been refused in some quarters. Black sheets are quoted at £7 10s. to £7 12s. 6d. for singles, with 2s. 6d. additional for doubles and 12s. 6d. for lattens.

### Pig Iron.

Pig iron is quiet, selling rather more freely. Smelters meet pressure for further concessions with a firm negative. Some of the prices quoted for South Staffordshire common forge are out of adjustment with the market generally, being almost on an equality with part-mine at 50s. to 51s. Best all-mine forge makes 85s. to 90s., and best all-mine foundry 92s. 6d., with cold blast 125s. Northamptonshire forge qualities range from 47s. 6d. to 49s. Derbyshire prices are rather stiff at 51s. 6d. to 52s. 6d. There is still no break in foundry iron prices. Smelters' policy of blowing out furnaces to keep over-production from depressing prices in this branch of the market seems to have been very successful.

### The New Prices for Steel.

The new prices in the steel trade to which prominent reference was made last week in this report show that in this part of the kingdom the reduction in plates and angles has been an average of 5s. per ton. The fact that the bulk of the Midland steel sales are confined to this district has no doubt weighed with makers in proclaiming only half the reduction of Cleveland steel, the market here being far less exposed to attack than those of the North-East and Scotland. Bridge builders and other large contractors protest that they are seriously handicapped in tendering for outside jobs. For the present the bridge building yards are moderately well employed, and new business is increasingly difficult to negotiate. In the Midlands plates are now quoted £6 7s. 6d. for small lots and £6 5s. for lots of 100 tons and upwards. Angles are £6 and £5 17s. 6d. The position with regard to joists is necessarily contingent upon the issue of the strike in the building trade, as to which a hopeful view is now taken here. This week's price is named as £6 15s. per ton. Steel half-products are quoted this week:—Bessemer sheet bars, £4 12s. 6d. to £4 15s.; and Siemens sheet bars, £4 15s. to £4 17s. 6d.

### Prosperity of Motor Engineering.

Excellent prosperity continues to mark the motor engineering industry in Birmingham, Coventry, and Wolverhampton, and makers are congratulating themselves on the way in which the demand keeps up. The good business is for both the home and overseas markets, and the prosperity of the Midland industry is especially gratifying in view of the increasing competition which American makers are setting up in all the best markets, and particularly in cheap cars, in this country

The imports of complete cars, chassis, and parts during the first four months of this year were valued at £3,059,073, compared with £2,573,850 in the corresponding period of 1913 and £2,419,547 for 1912. In the same period our exports of motor cars and chassis were of the value of £876,236, compared with £853,586 in 1913 and £757,152 in 1912, and parts brought the totals up to £1,349,273 in 1914, £1,391,535 in 1913, and £1,136,352 in 1912.

**New Scale of Colliery Surfacemen's Wages.**

The North Warwickshire Miners' Association state that the coalmasters have agreed to the following scale of wages for surfacemen when wages stand at 65 per cent. over basis rates :—14 to 14½ years of age, 1s. 8d. per shift ; 14½ to 15, 1s. 9d.; 15 to 15½, 1s. 10½d.; 15½ to 16, 2s.; 16 to 16½, 2s. 3d.; 16½ to 17, 2s. 6d.; 17 to 17½, 2s. 9d.; 17½ to 18, 3s.; 18 to 18½, 3s. 2d.; 18½ to 19, 3s. 4d.; 19 to 19½, 3s. 6d.; 19½ to 20, 3s. 8d.; 20 to 20½, 3s. 10d.; 20½ to 21, 4s.; over 21, 4s. 1d. The above list is to apply to able-bodied and thoroughly competent men only.

## NOTES FROM LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

**A Dull Market.**

THERE was a comparatively small attendance on the Iron Exchange on Tuesday, and business in all departments could only be described as being idle in character. There was little new to record in either pig iron or steel and steel products, and prices must, to a great extent, be regarded as nominal. Finished iron easier. Copper and sheet lead also quiet and unchanged. English tin ingots showed a reduction.

**Quotations.**

Pig iron : Lincolnshire No. 3 foundry, 55s. 9d.; Staffordshire, 55s. 6d.; Derbyshire, 56s. 6d.; Northamptonshire, 57s.; Middlesbrough, open brands, 60s. to 60s. 8d. Scotch (nominal) : Gartsherrie, 66s. 6d. to 67s.; Glengarnock, 65s.; Eglinton, 64s.; Summerlee, 66s. to 66s. 6d., delivered Manchester. West Coast hematite, 64s. 6d. to 65s.; East Coast ditto, 61s., both f.o.t. Delivered Heysham : Gartsherrie, 64s. 6d. to 65s.; Glengarnock, 63s.; Eglinton, 61s.; Summerlee, 64s. to 64s. 6d. Delivered Preston : Gartsherrie, 65s. 6d. to 66s.; Glengarnock, 64s.; Eglinton, 62s. 6d.; Summerlee, 65s. to 65s. 6d. Finished iron : Bars, £7 5s.; hoops, £7 7s. 6d. to £7 12s. 6d.; sheets, £8 7s. 6d. to £8 12s. 6d. Steel : Bars, £6 7s. 6d. to £6 12s. 6d.; Lancashire hoops, £7 7s. 6d. to £7 10s.; Staffordshire ditto, £7 17s. 6d. to £8 ; sheets, £9 to £9 5s.; boiler plates, £7 5s.; plates for tank, girder and bridge work, £6 5s. to £6 10s.; English billets, £4 15s. to £4 17s. 6d.; foreign ditto, £4 5s. to £4 7s. 6d.; cold drawn steel, £9 5s. to £9 10s. Copper : Sheets, strips, &c., £77 per ton, small lots, 10d. per lb.; rods, £75 per ton, small lots, 10d. per lb. tough ingots, £67 10s.; best selected, £68 to £68 10s. Copper tubes, 9½d.; solid drawn brass, 7½d.; brazed brass tubes, 9½d.; condenser tubes, 8½d.; condenser plates, 7½d.; rolled brass, 7d.; brass turning rods, 6½d.; brass wire, 7½d.; yellow metal, 7½d. to 7¼d. per lb. Sheet lead, £22 per ton. English tin ingots, £141 per ton.

**The Lancashire Coal Trade.**

The attendance on the Coal Exchange was fairly well up to the average for time of the year. The hot weather is militating greatly against business, and demand for house coal is very small. The basis for contracts over next year has not yet been definitely decided upon, although it is generally thought that about last year's level will be maintained. It was reported, however, that a few special contracts had been put through at about 3d. per ton under last year's figures. Business in slacks and engine fuel is still quiet, and movement on shipping and bunkering account is also very poor. Quotations :—Best Lancashire house coal, 17s. 8d. to 18s. 10d.; good medium, 16s. 2d. to 17s.; domestic fuel, 13s. 5d. to 14s. 5d.; screened steam coal, 11s. 6d. to 13s.; slacks, 9s. to 10s. per ton at the pit.

**Chester Hydro Electricity Works.**

Mr. S. E. Britton, engineer to the city of Chester, has kindly supplied me with some interesting data with regard to the cost of operating the above plant, from which it appears that on March 25th last, the end of the financial year, the works had been in operation twenty-three weeks, during which period 736,310 units were generated, of which 15.5 per cent. were used for excitation, sewage pumping, lighting of works, and loss in distribution, leaving 630,427 units supplied to customers. The cost over this period was made up as follows :—Oil, waste, and stores, £24 13s. 5d.; wages, £102 14s. 10d.; repairs, £2 6s.; rent, £49 18s. 6d.; rates, £66 16s. 1d.; insurance, £2 7s.; general establishment charges, £50 ; total, £298 6s. 10d., or 0.112d. per unit. The interest on loans amounted to £372 10s. 7d.; and sinking fund, £181 12s. 7d.; making £554 3s. 2d. for total capital charges, or 0.208d. per unit. The total expenditure for the undertaking was therefore £852 19s., which is equal to 0.322d. per unit sold. These results are superior to those estimated by Mr. Britton. He calculated the annual yield of the plant to be about 1,350,000 units at a cost of 0.35d. per unit, as stated in THE ENGINEER for October 17th, 1913.

**Water Purification for Swimming Baths.**

At the annual meeting of the Institution of Water Engineers, held in Stockport last week, Mr. J. Holme Lewis, the hydraulic engineer to the Manchester Corporation, read a paper in which he described the means employed by the corporation to purify the water used in the local swimming baths by continuous aeration and filtration. He said the system employed in over one hundred plants had proved capable of maintaining water, even when continually fouled by body contact, free from all offensive smell, and in a bright, clear, and otherwise satisfactory condition for an indefinite period. He claimed for the system of aeration and filtration that it provided greatly improved and uniform conditions in the baths without adding to the cost of administration, and was capable of effecting a substantial saving in the amount of water used.

BARROW-IN-FURNESS, Thursday.

**Hematites.**

The position of the hematite pig iron trade has undergone no change during the past week. On every hand good orders for iron are held, and the metal being produced is going into prompt consumption for the most part. Makers are, however, not experiencing a very full demand for iron, for there is no disposition on the part of users to place orders except for small parcels. In the meantime old orders are being worked on. Steel makers are taking large tonnages direct from the works at both Barrow and Workington. Prices are steady, with mixed numbers of Bessemer iron quoted at 66s. to 67s. per ton net f.o.b. For special brands of iron for very high-class work there is a steady demand. This iron is made at Barrow and also at some works in Cumberland, and is quoted at 72s. to 74s. per ton. There is nothing doing in warrant iron, which is nominally quoted at 61s. per ton net cash. The stores of warrant represent in the aggregate just over 8000 tons.

**Iron Ore.**

There is a steady demand for ore in this district, but that demand is not quite so full as it has been. At the same time some fairly good stores of ore are held at some of the pits' mouths. Prices are about the same, with good average qualities quoted at 13s. 6d. to 15s. 6d., and the best ores, such as the Hodbarrow qualities, are quoted at 20s. per ton net at mines. For Spanish ores there is a steady call, and last week a large cargo was discharged into Barrow for local use. This ore is quoted at 16s. to 17s. per ton. Irish ores are only brought into Barrow now and again.

**Steel.**

The steel trade is pretty well employed on rails, but it is by no means working at top pressure. The output, all the same, is considerable, and the rails are being sent to home users, direct to the Colonies, and to Liverpool, where large cargoes on overseas account are made up. The Barrow Steel Company has an order for 10,000 tons of rails for Nigeria. Rails of heavy section are quoted at £5 17s. 6d. to £6 2s. 6d. per ton. Little is being offered in light rails or heavy tramway sections. For steel shipbuilding material there is a steady demand on local as well as general home account. Some good orders are held and the plate mill at Barrow is well employed. Ship plates are at £6 10s. to £6 15s. per ton, with boiler plates at £7 10s. to £7 15s. per ton. Hoops are at £8 5s. per ton, and represent a fair business.

**Shipbuilding and Engineering.**

These trades are well employed in every department. Messrs. Vickers Limited have laid down the first keel plate of the Turkish battleship, the order for which was noted a few weeks ago. A lot of work is yet to be done before the Turkish battleship Reshadieh can leave Barrow for her trials, but the job is being pressed forward.

**Fuel.**

For coal there is a good demand at 15s. to 17s. per ton. Coke is in full request at 19s. to 22s. per ton for East Coast sorts, 19s. for Welsh coke, and Lancashire qualities are at 18s. per ton delivered.

**Shipping.**

The export shipping trade of Barrow is fairly well employed on pig iron, steel products, &c. Large imports of oil and foreign ore have recently been noted.

## THE SHEFFIELD DISTRICT.

*(From our own Correspondent.)*

**General Conditions.**

DURING the past week there appears to have been rather an improvement in the general outlook, though it is not sufficient to do more than steady the nerves of those who feared the whole district was on the verge of a serious slump. Orders have been coming in very well numerically, but the tonnage seems to be much lighter. A few large firms which were reported to be exceedingly short of work now appear to be doing better, one place in particular being quite active, though whether this is upon really remunerative contracts is another question. There are still instances, however, where firms are badly in need of new business and do not hesitate to admit the fact. Generally speaking, works are "picking their way" through the summer, glad of any little improvements that occur—such as the present one—in the hope that the autumn will bring with it better business. Bar iron makers—at least, crown bar makers—believe that the worst of the slump they have experienced for months now has been seen, and it is quite possible that that will prove to be the case. The Association adheres to the £7 5s. basis price, but I understand that outside firms have been doing business at less. Heavy ironfoundries are busy on large castings for engineers and pipe departments have nothing to complain of. Edge tools fell away rather appreciably a few months ago, but things have quite revived again and manufacturers of saws have not yet succeeded in completely overtaking arrears of orders. Preparations for the harvest are being made in various parts of Russia and other countries to which such things as reaper sections are sent from here, and trade prospects are good ; but the unsettled state of the Balkans is seriously felt. Files and drills are a healthy branch of the steel industry, and makers of case-hardened steel for motor car building are experiencing a quite satisfactory output. Wire rope makers for colliery, torpedo net, &c., purposes and nut and bolt makers for Admiralty work seem to be doing well, and the armament works will, of course, know no really slack times for a year or so at least.

**Round the Works.**

Included in the volume of new business booked during the past week is an order from the Tasmanian Government for wheels and axles to the value of £1800. Three good hardware contracts have been secured locally for Lagos and Demerara, and two firms are to make quantities of files for Lagos and Barcelona. Large tonnages of steel are in hand for Vancouver, New York, Chicago, Montreal, and Calcutta. Other contracts include shovels for Delagoa Bay, tools for Sydney, N.S.W., steel for Johannesburg and the United States, electro-plate for Sydney, and cutlery for Mollendo (Peru) and Kingston (Jamaica). One firm has secured a contract for the supply of special trackwork for the relaying of tramways for the Bolton Corporation, and the same people are delivering large quantities of similar material to the Sheffield Corporation. Several very large contracts for circular saws on foreign account have been booked, and heavy engineers are sending out a good deal of work just now on home and oversea orders. One firm, very actively employed in similar work on foreign account, is just now delivering a 12,000-ton armour plate bending press to Cammell, Laird's. This press will be thé largest of its kind in the world, and has been a year or two under construction, Cammell's making all the forgings and castings themselves.

**Pig Iron and Billets.**

The pig iron market has developed no new feature of any particular note. It is improbable that consumers really believe otherwise than that in almost all cases the bottom of the market has been reached, but they can see no reason for fearing an advance under present conditions : therefore they seem content to leave the forward market alone. With the slightest tendency for prices to rise, however, there is little doubt that buyers would come in for contracts. Most of the latter expire with this month, and then makers will simply be delivering on hand-to-mouth orders, for there seems little being said at the moment about renewals of contracts. In that sense the experience of last year is being repeated. Special makes of West Coast hematite continue in pretty fair demand, prices, of course, varying according to specification, but ordinary quality keeps at about 73s., warrants being 3s. less or lower. East Coast hematite mixed numbers show rather an easier tendency at about 67s. to 67s. 6d., though less has been taken. Derbyshire foundry is firm at 53s. to 53s. 6d., and forge is quoted about 50s. The official prices of Lincolnshire foundry and forge remain at 54s. 8d. to 55s. 2d. and 53s. 8d. respectively, but where business offers makers are stated to be meeting buyers at 1s. less than these figures. Basic is quoted 55s. 8d. Sheffield. Billets are still open for a lot of improvement, the demand not having nearly overtaken the supply, and continental stuff continues to be imported at about 84s. for dead soft. Local hard basic is done at 110s., or a little lower, and soft at about 95s. Siemens acid billets are about £6 15s. to £7 and Bessemers £6 10s. to £6 15s. Hoops are quoted at £7 12s. 6d. Scrap of all kinds is a slow market.

**Fuels.**

The hardening tendency in steam coals continues, and the recent prospects of cheaper fuel appear to be receding again. The tonnage going for shipment compares unfavourably with this period last year, and the lost ground cannot now be recovered, but what improvement is possible is now taking place and the outlook is promising. For industrial sorts the heavy trade demand is fairly strong, but the same cannot be said for the lighter trades, which mark a distinct falling off. Gas fuels are a moderately good market for contract and shipments are better. The cheaper grades of slacks can be picked up at low rates, but the better qualities are in request, though perhaps a little irregular. The output of all kinds of coal in the Sheffield area is increasing in a remarkable manner, and this fact must presently exercise a considerable influence upon the question of price. Best South Yorkshire hards are quoted 11s. 3d. to 11s. 6d., and best Derbyshire 10s. 6d. to 10s. 9d., with second qualities at 9s. 6d. to 10s. Coke is still slumpy, the market for beehive and patent ranging from 10s. to 10s. 6d. at pit.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

**Cleveland Iron Trade.**

THE Cleveland pig iron trade is altogether lacking in buoyancy just now, and there appears to be no immediate prospect of any movement which will stimulate the trade into renewed activity. The market is in a lifeless condition, pig iron consumers showing no disposition to do more than cover immediate wants. But whilst business continues on a very limited scale, the inherent strength of the trade at the present time is such that for the most part prices are well maintained, and there can be little doubt that the revival when it comes will be accompanied by a steady upward movement of prices. The present position, however, in no wise justifies a pessimistic view. Further withdrawals of iron have been made from the public warrant stores, and the total amount now held is just over 84,000 tons. This practically represents the only available reserve, as makers' stocks are very low indeed, and the whole of the output of the district may be said to be going into immediate consumption. The makers' policy of restricting the make is being strictly adhered to, and, indeed, it is possible that more furnaces may be put out of blast if the cost of fuel is not reduced, as makers still complain that they are working at a loss. At present there are only seventy-four furnaces in blast on the North-East Coast, as against eighty-nine a year ago, and this reduction in the make of iron has undoubtedly exercised a steadying influence upon the Cleveland iron market. News as to the actual amount of the rebate on imports of pig iron into Russia is being anxiously awaited by Cleveland ironmasters, hopes being entertained that it will give a filip to their trade. No. 3 G.M.B. Cleveland pig iron is 51s. 4½d.; No. 1, 53s. 10½d.; No. 4 foundry, 51s. 1½d.; No. 4 forge, 50s. 7½d.; and mottled and white iron, each 50s. 1½d.—all for either early or forward delivery.

**Hematite Pig Iron.**

There is no improvement to note in the general condition of the hematite pig iron trade on the North-East Coast. New business is coming to hand but slowly, and prospects of a revival, at least at present, are not of the best. There is a certain amount of uncertainty all round, and consumers will not place contracts for more than immediate requirements, and this in face of the much lower rates that are in vogué for iron. At the moment, makers are holding orders that drain their output, steel makers locally and on general home account taking good supplies, but they are booking very little for forward delivery. The market position is very weak, and values continue to droop. In the early part of the week business was recorded at 59s. 9d., but that figure has been broken, and 59s. 6d. is now the general market quotation for practically any delivery of mixed numbers. Whether even that quotation will be maintained is open to doubt, as sales are reported at lower prices.

**Iron-making Materials.**

There is very little business being done in the foreign ore trade, which has for some time been quiet. Consumers, as a rule, have good stocks and are not disposed to place contracts at the present quotation, which is considered too high and out of proportion with the current prices of iron. The sellers' quotation remains nominally on the basis of 17s. 6d. for best Bilbao Rubio of 50 per cent. quality, ex ship Tees. The phenomenal strength of the coke trade shows no signs of relaxation, and 17s. 6d. is still demanded for good medium furnace kinds delivered at the works. It is almost a prohibitive figure with iron at its present price, and consequently there is a good deal of Yorkshire coke finding its way into the Cleveland district at fully a shilling a ton less than Durham coke.

**Manufactured Iron and Steel.**

The finished iron and steel trades share in the prevailing apathy. While there is no lack of employment at present in the steel industry, orders for the future are comparatively scarce, and prospects of an early improvement are anything but bright. Most of the rail mills are busily employed, but so far the reduced price of steel ship plates and angles has not appreciably improved the demand. There has been a reduction of 10s. per ton in the price of steel boiler plates, and also for Siemens steel bars. The finished iron trades are but indifferently employed, makers having to contend with a good deal of foreign competition. The following are the principal market quotations :—Common iron bars, £7 ; best bars, £7 7s. 6d.; best best bars, £7 15s.; packing iron, £5 15s.; iron ship angles, £7 ; iron engineering angles, £7 ; iron ship plates, £6 15s.; iron girder plates, £7 5s.; iron ship and girder rivets, £7 5s.; steel bars, basic, £6 5s.; steel bars, Siemens, £6 5s.; steel ship angles, £5 15s.; steel ship plates, £6 ; steel boiler plates, £7 ; steel engineering angles, £5 17s. 6d.; steel sheets, singles, £8 5s.; steel sheets, doubles, £8 10s.; steel joists, £6 12s. 6d.; steel hoops, £6 10s.; steel strip, £6 5s.—all less the usual 2½ per cent. f.o.t. Heavy steel rails, £6 ; steel railway sleepers, £7 5s.; light iron rails, £7—all net at works. Cast iron chairs, £4 5s.; cast iron pipes, 1½in. to 2in., £6 7s. 6d.; 3in. to 4in., £6 ; 5in. to 8in., £5 15s.; 10in. to 16in., £5 17s. 6d.; 18in. to 24in., £5 17s. 6d.; cast iron columns, plain, £7 7s. 6d.; floor plates, £3 10s.—f.o.r. at makers' works. There has been no expansion in the demand for galvanised sheets, which are quoted at £11 to £11 5s. per ton of 24 gauge, less the usual 4 per cent.

**Shipbuilding and Engineering.**

The shipbuilding trade on the North-East Coast continues in a healthy condition, no sign of weakening being visible, and great activity is the rule at most of the works. The orders placed this week include two cargo steamers to be built by Bulwer and Co., Sunderland, and two also of great capacity by Readhead and Co., South Shields. All four vessels are for the Moor Line, Newcastle. R. Ropner and Sons, Stockton, have also booked an order for a cargo steamer from Constantine, Pickering and Co., Middlesbrough. The various departments of the engineering trade have fairly good employment, and orders that will keep them going for some months to come.

**Coal and Coke.**

Business on the coal market rules on extremely disappointing lines ; there is very little forward inquiry, and spot business is at a standstill. A large number of Northumberland

as well as Durham pits are losing time through want of tonnage. Many of them are fully sold out for this month, and the shortage of tonnage is therefore a real hardship. The threatened sea-going engineers' strike is also affecting the market to an extent, and with the outlook so uncertain traders are disinclined to move. The general quotation for best Durham gas coal is 13s., and second qualities round about 12s. Steam coals show much firmness. Bunker coals are in fair demand, ordinaries being quoted at 11s. 3d. to 11s. 6d., and best at 12s. 6d. to 12s. 9d. Coke is firm but quiet. Best foundry coke is 19s. to 20s.; furnace coke, 17s. 6d., and gas coke 13s.

## NOTES FROM SCOTLAND.

*(From our own Correspondent.)*

### The Warrant Market.

THE volume of business transacted in the Glasgow pig iron warrant market during the week was again small, and amounted to about 6000 tons. Owing to the absence of business prices did not fluctuate to any extent, and Cleveland iron closed at 51s. 2d. per ton cash buyers, showing a decline of 1d. per ton on the week.

### Pig Iron.

The demand for ordinary qualities and hematite is small, and makers are beginning to find it difficult to dispose of their outputs, even although the rate of production has not increased. Shipments have been restricted, with the result that stocks in Middlesbrough stores have increased by 1017 tons, making the total in store 85,160 tons. The import of pig iron into Grangemouth from Middlesbrough and district amounted during the week to 10,138 tons. There are 72 furnaces in blast in Scotland, the same number as last week, and 17 fewer than in the same week of 1913.

### Quotations.

The prices of makers' iron have been reduced 1s. per ton, and are as follows:—Monkland, f.a.s. at Glasgow, No. 1, 61s. 6d.; No. 3, 60s.; Govan, No. 1, 61s.; No. 3, 60s.; Carnbroe, No. 1, 65s. 6d.; No. 3, 62s. 6d.; Clyde No. 1, 67s.; No. 3, 62s.; Gartsherrie, Summerlee, Calder, and Langloan, Nos. 1, 67s. 6d.; Nos. 3, 62s. 6d.; Glengarnock, at Ardrossan, No. 1, 70s.; No. 3, 65s.; Eglinton, at Ardrossan or Troon, No. 1, 61s.; No. 3, 60s.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 60s.; Shotts, at Leith, No. 1, 67s. 6d.; No. 3, 62s. 6d.; Carron, at Grangemouth, No. 1, 68s.; No. 3, 63s. per ton.

### Finished Steel.

Steel makers report that orders are a little more plentiful than has been the case for some time back, but that they are still experiencing some difficulty in keeping mills occupied. Owing to the strike at the Steel Company's Hallside Works, also Lanarkshire, other sectional makers are considerably better off for orders. Merchants and consumers are still willing to contract ahead, but makers are apparently decided not to book any forward business at the present rates.

### Finished Iron.

No improvement can be reported in the position of the various branches of the finished iron trade. Black sheet makers are feeling the effects of a scarcity of orders, and works are not nearly so well employed as they were a week or two ago, while galvanised sheet makers could also do with an increase in the number of orders booked. There has been no change of note in the malleable iron branch of the trade. The amount of business passing continues very small, and plants are not employed to anything approaching their productive capacity. It appears to be generally accepted that until there is a large diminution in the quantity of foreign imports of a competitive nature the malleable iron trade cannot be much better off than at present.

### The Coal Trade.

Business in the Scotch coal trade has continued on much the same lines as in the preceding week. The market in the West of Scotland is a little better off so far as orders for ells are concerned, owing to the fact that fair quantities of this class have been bought during the past few days in anticipation of a rise in price before the end of the month. Splints are busy, and navigations maintain their position, while ordinary steams are still weak. There are indications of better trade in the Lothian district, and, although the market in Fifeshire is a trifle easier, this is accounted for by the small quantity of tonnage at the ports. The aggregate shipments from Scottish ports during the week reached the total of 327,902 tons, compared with 279,976 tons in the preceding week and 358,045 tons in the corresponding week of last year. Ell coal is quoted f.o.b. at Glasgow 11s. to 11s. 3d.; splint, 10s. 9d. to 14s.; navigation, 14s. 6d. to 14s. 9d.; steam, 10s. 6d. to 12s. 9d.; treble nuts, 11s. 3d. to 11s. 6d.; doubles, 10s. 6d. to 10s. 9d.; singles, 9s. 6d. to 10s. per ton.

### Miners' Wages.

A meeting of the Scottish Coal Trade Conciliation Board was held in Glasgow during the week to consider the application by the coalowners for a reduction of 1s. per day in miners' wages. Lord Balfour of Burleigh, who acted as independent chairman and arbiter, said at the close that he was satisfied that the prices obtained for March and April warranted a reduction of 6½ per cent. on the 1888 basis. This reduction, representing 3d. per day, brings the rate of wages down to 7s. per day.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### Cardiff Coal Trade.

DURING the past week large coals have been sharply divided, both as regards tone and value, whereas Admiralty qualities generally and best Monmouthshires have been almost unobtainable and have been extremely firm, ranging up to 22s. for best Admiralties. All other descriptions of large have been plentiful and easy, though towards the middle of the week some of the inferior coals slightly steadied. As regards the Admiralty qualities, reports were current that the Turkish and Greek Governments were in the market for extra supplies in view of the strained relations between these countries. What the exact quantities are it is difficult to ascertain, inasmuch as this business invariably circulates through so many channels that what originally was little more than a few cargoes is made out to be four or five times as much. Then there have been inquiries for 22,000 tons for the German navy when cruising in Norwegian waters, and prices have gone in for about 10,000 Admiralty coals for the Norwegian navy. The British Admiralty have started to ship heavier quantities, and all these factors have imparted a strong tone to the market for the better classes of steam coals. As a matter of fact, it is not seriously expected that the German navy or Norwegian navy requirements will be taken from South Wales on account of the relatively high prices demanded, but the position is that most of the collieries supplying Admiralty qualities are well sold, if not oversold, for some time, and in many cases they are not prepared to quote at all. As regards the very tip-top sorts, so very little is held by middlemen that any buyer committed to the best has no option but to pay the prices demanded by the colliery salesmen, who have been able to do 22s. for the best, superior seconds being about 19s. to 19s. 9d., and ordinary seconds about 18s. 6d. Dry coals have been steady and best Monmouthshires very firm, but other grades have shown extreme irregularity, though now recovering and displaying a steadier tone, as tonnage showed an improvement over the last week-end. Small coals showed a sagging tendency until about the middle of this week, when a better inquiry set in, but prices have not moved much from 11s. for best bunkers and up to 8s. 9d. for cargo sorts. The threat of marine engineers to strike in support of their demands for higher wages caused some excitement on Wednesday, but later in the day it was not taken very seriously, though business was considerably upset and will continue so until the position becomes clearer. Local shipowners stated that no applications had been made for any improved remuneration since 1912, when the present scale in force was agreed upon by a committee of shipowners and representatives of the Marine Engineers' Association, the Amalgamated Society of Engineers, and the Steam Engine Makers' Society. Officials and members of the Cardiff branch of the Marine Engineers' Association met on Tuesday night to make arrangements for calling out the engineers on Wednesday in accordance with the decision of the joint executive committee of the three organisations concerned. Only those engineers who have not signed articles are apparently to be appealed to to support the movement, those who have signed going to sea without any interference. The idea is to persuade all engineers on incoming boats to decline to renew agreements so that it will be some time before the full force of the strike will be felt. Evidently the marine engineers are not counting on sympathetic action, as if all men who are members of the various engineers' societies, employed in and about the docks, suspended work the whole coalfield would be rendered idle in little more than twenty-four hours.

### Approximate Values.

Steam coal: Best Admiralty large, 21s. to 22s.; best seconds, 19s. to 19s. 9d.; seconds, 18s. 3d. to 18s. 9d.; ordinaries, 17s. 6d. to 18s.; best drys, 18s. 6d. to 18s. 9d.; ordinary drys, 16s. 3d. to 16s. 9d.; best bunker smalls, 10s. 9d. to 11s.; best ordinaries, 10s. to 10s. 6d.; cargo smalls, 8s. to 8s. 9d.; inferiors, 7s. to 7s. 9d.; washed smalls, 12s. to 12s. 6d.; best Monmouthshire black vein large, 17s. 6d. to 18s.; ordinary Western Valleys, 16s. 3d. to 16s. 9d.; best Eastern Valleys, 16s. 3d. to 16s. 6d.; seconds, Eastern Valleys, 15s. 6d. to 16s. Bituminous coal: Best households, 19s. to 20s.; good households, 17s. to 19s.; No. 3 Rhondda large, 17s. 6d. to 18s.; smalls, 12s. to 12s. 6d.; No. 2 Rhondda large, 12s. 9d. to 13s. 6d.; through, 11s. 6d. to 12s.; smalls, 8s. 6d. to 9s.; best washed nuts, 15s. 6d. to 16s.; seconds, 14s. to 14s. 9d.; best washed peas, 14s. 6d. to 15s.; seconds, 13s. to 13s. 6d. Patent fuel, 19s. to 21s. 6d. Coke: Special foundry, 29s. to 30s.; good foundry, 22s. to 25s.; furnace, 17s. to 19s. Pitwood, ex ship, 20s. to 20s. 6d.

### Newport (Mon.).

A better tone became more evident in Monmouthshires this week as the result of improved tonnage supplies. Best black veins have for some weeks been very difficult to obtain, as they are so well sold, but for practically all other grades values were very irregular and easy last week-end, but the tonnage question was the chief difficulty, and with vessels coming to hand better over the week-end a steadier feeling has gradually been shown this week. The demand, however, keeps quiet on the whole, though smalls, through coals, and nuts show an improving tendency. Approximate quotations:—Steam coal: Best Newport black vein large, 17s. 3d. to 17s. 9d.; Western Valleys, 16s. 3d. to 16s. 6d.; Eastern Valleys, 16s. to 16s. 3d.; other sorts, 15s. 6d. to 15s. 9d.; best smalls, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s. Bituminous coal: Best house, 18s. to 19s.; seconds, 16s. 6d. to 17s. 6d. Patent fuel, 19s. 6d. to 20s. Pitwood, ex ship, 20s. to 20s. 6d.

### Swansea.

The demand has this week been very slow for several of the leading descriptions, and tonnage supplies have been relatively poor. Swansea Valley large has shown little change in quotation, though prompt supplies were easy. Machine-made coals were also obtainable on rather more favourable terms for early shipment, but rubbly culm has been steady. In the steam coal section only the best qualities have been good in tone, smalls being steady. Anthracite: Best malting large, 21s. 6d. to 23s. net; second malting large, 17s. 6d. to 18s. 9d. net; big vein large, 15s. 3d. to 16s. 3d., less 2½ per cent.; red vein large, 12s. 9d. to 13s. 6d., less 2½ per cent.; machine-made cobbles, 21s. to 22s. 3d. net; French nuts, 21s. 9d. to 23s. 9d. net; German nuts, 21s. 9d. to 23s. 6d. net; beans, 16s. 3d. to 18s. net; machine-made large peas, 11s. 9d. to 13s. 3d. net; rubbly culm, 6s. 6d. to 6s. 9d., less 2½ per cent.; duff, 4s. 6d. to 4s. 9d. net. Steam coal: Best large, 18s. 9d. to 21s. 9d., less 2½ per cent.; seconds, 14s. 6d. to 15s. 6d., less 2½ per cent.; bunkers, 10s. 9d. to 11s. 6d., less 2½ per cent.; smalls, 8s. 3d. to 9s. 3d., less 2½ per cent. Bituminous coal: No. 3 Rhondda large, 17s. to 18s., less 2½ per cent.; through and through, 14s. to 15s., less 2½ per cent.; smalls, 11s. to 11s. 9d., less 2½ per cent. Patent fuel, 17s. to 17s. 6d., less 2½ per cent.

### Tin-plate and Other Quotations.

I.C., 20 × 14 × 112 sheets, 12s. 1½d. to 12s. 3d.; I.C., 28 × 20 × 56 sheets, 12s. 4½d. to 12s. 6d.; I.C., 28 × 20 × 112 sheets, 24s. 3d. to 24s. 6d.; I.C. ternes, 28 × 20 × 112 sheets, 22s. to 22s. 6d.; finished black plates, £9 10s. per ton; galvanised sheets, 24 g., £10 15s. to £11 per ton. Block tin, £136 7s. 6d. per ton cash, £138 5s. per ton three months. Copper, £61 12s. 6d. per ton cash, £62 per ton three months. Lead: English, £20 per ton; Spanish, £19 15s. per ton. Spelter, £21 7s. 6d. per ton. Silver, 2s. 1 1/16d. per ounce.

### Iron and Steel Trades.

Pig iron: Standard iron, 50s. 9d. cash, 50s. 10½d. month; hematite mixed numbers, 61s. cash, 61s. 1½d. month; Middlesbrough, 51s. 1½d. cash, 51s. 3d. month; Scotch, 57s. 1½d. cash, 57s. 3d. month; Welsh hematite, 65s. dd.; East Coast hematite, 65s. c.i.f.; West Coast hematite, 66s. to 67s. c.i.f. Steel bars: Siemens, £4 11s. 3d. per ton; Bessemer, £4 10s. per ton. Steel rails, heavy sections, £6 2s. 6d. per ton. Iron ore: Rubio, 17s. to 17s. 3d.

## CATALOGUES.

MELMS AND PFENNINGER G.M.B.H., Munchen-Hirschau, Germany.—We have received from this firm an extensive and well got up catalogue on steam turbines. It illustrates and describes all the component parts, and gives a good deal of information concerning steam consumption. The catalogue also deals with condensers, air and circulating pumps, &c.

WE have received from Schuchardt and Schutte list K91, dealing with precision engine lathes. It contains many illustrations of these lathes, complete descriptions and prices and dimensions. The lathes are supplied for belt or foot power or for direct motor drive. From the same firm we have also received lists dealing with worm and plain milling machines.

FROM J. H. Holmes and Co., of Portland-road, Newcastle-on-Tyne, we have received a well got up catalogue dealing with electrically driven machines for mines. It illustrates power plants, dynamos and motors, electrically driven pumps of various types, haulage gears of various types, mechanical speed gears coupled to Holmes electric motors, electrically driven air compressors, coal cutters, high-tension switches, mining switch pillars, haulage controllers, liquid starting switches, switchboards, &c.

ALFRED HERBERT'S monthly review on modern machine shop practice has reached us. It contains articles on "Factory Lay-out and Equipment," "Using Soft Jaws," "Progress," "A Small Dynamo Spindle," "Vickers Vanadium Twisted Drills," "A Good Turret Lathe Job," "Cutting Millimetre Pitches," "Making Light Car Clutch Parts," and "Producing Bar Work on Capstan Lathes." The publication is full of useful information, and should interest all associated with engineering works.

SIR WILLIAM ARROL AND CO., 57, Queen Victoria-street, E.C.—An extensive book of engravings has reached us. On the first page is an illustration of the largest cantilever crane made in this country. Other pages illustrate overhead travellers of large size, shipbuilding cranes, shipbuilding berths, electrically operated forge cranes, portable steam gantry cranes, special steam cranes for steel works, automatic dumping skips, electric capstans, trolley hoist transporters, &c. Many of the illustrations showing cranes, &c., in use are decidedly interesting.

JOHN I. THORNYCROFT AND CO., Limited, have issued a new catalogue of marine motors and motor boats which shows a very wide range of engines from 7½ brake horse-power to 150 brake horse-power, using paraffin, and also capable of running on petrol. They also supply a special range of engines designed for petrol only. The matter is arranged in such a form that all the information required is most easily obtained. The catalogue also contains particulars of a good range of motor boats, of light high-speed launches, sea-going pleasure craft, motor life-boats, service vessels, cargo vessels, shallow-draught launches, &c., and all these, as well as the engines, are very fully coded for the convenience of foreign customers.

THE Photostat is dealt with in a well got up pamphlet forwarded to us by Alfred Herbert, Limited, of Coventry. The Photostat, as probably many of our readers are aware, is practically a large camera equipped with self-contained developing and fixing arrangements, and fitted with graduated scales for focussing without the use of a ground glass screen. The subject to be copied is photographed directly on the sensitised paper, which becomes the finished print. This paper is in a continuous roll, contained inside the camera body; suitable means are provided for cutting off each sheet after exposure and for passing it into the developing bath without it being touched by the hand. The advantages claimed for the Photostat are set forth clearly.

WE have been asked to say that the small paragraph on the cycle-riksha in our issue of June 5th appeared originally in the *Indian and Eastern Engineer*.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The members of the Institution of Automobile Engineers are to pay a visit to Belgium next month. The following provisional arrangements have been made:—On Saturday, July 11th, the party will leave Liverpool-street (Great Eastern Railway) at 8.40 p.m. for Parkeston, and will arrive in Antwerp on the morning of Sunday, July 12th, at 8 a.m. On the Monday, at 8.30 a.m., members will proceed in special trams to the works of the Minerva Motor Company, arriving there at about nine o'clock. The directors have made arrangements to show the members over the works and to entertain them to luncheon in the Zoological Gardens at twelve, on the conclusion of the inspection. After luncheon the members will take the train for Liège, which will be reached in about 2½ hours, and there the night will be spent. On the Tuesday, at 9 a.m., special trams will take the party to the works of the Fabrique Nationale d'Armes de Guerre (F.N.), where again the directors will show the members round, and entertain them to luncheon in the works at noon. After luncheon the party will proceed by tram to the works of the Usines G. Derihon, where they will be shown the manufacture of various parts of the automobile, particularly forgings and drop forgings, &c. On the Wednesday, at 9.15 a.m., members will leave by special tram for the works of the Société Anonyme John Cockerill at Seraing, where the directors will show them the erecting shops, forges, power station, steel foundry, and coal mine operating plant. In the afternoon train will be taken for Louvain, which will be reached in about 1½ hours. A visit will then be paid to the works of Messrs. Dyle and Bacalan, where the pressing of chassis frames, axle casings, &c., and the manufacture of cold-drawn steel tubes will be viewed. Leaving Louvain, Brussels will be reached in about ¾ hour. On the Thursday the party will leave Brussels about 8.45 a.m., arriving at Mariemont Station about 10.30. Here a visit will be paid to the works of Messrs. Mabille and R. Pelgrims, where steel castings and motor omnibus wheels are made. After the inspection of the works the directors will entertain the party to luncheon, and the return will be made to Brussels in the afternoon by about 5.30 o'clock. On the Friday the party will leave the hotel at nine and visit the carriage building factory of Messrs. Van den Plas, after which they will be entertained to luncheon by the Chambre Syndicale. The party will leave at 5.33, the train arriving alongside the Great Eastern Railway Company's steamer for Parkeston, which leaves at 7 p.m., and Harwich will be reached at 6 a.m. on the morning of Saturday, July 18th.

ROYAL METEOROLOGICAL SOCIETY.—The last meeting of this society for the present session was held on Wednesday afternoon, the 17th instant, at 70, Victoria-street, Westminster, Mr. C. J. P. Cave, president, in the chair. Mr. B. C. Wallis read a paper on "The Rainfall of the Southern Pennines." This inquiry had been undertaken with a view of attempting to find a scientific justification of the claim made for the wetness and humidity of Lancashire suitable to the manufacture of cotton. In summarising the distribution of the rainfall of the Pennine district the author said that it might be asserted that the west was wetter than the east on the whole, as a rule, although the difference between the two areas was least marked during the dry season from March to May. In June and July, however, the lowland of the Trent and Ouse Valleys received a relative excess of rainfall which was compensated by the relative dryness in December and January. The uplands were absolutely wetter than the neighbouring lowlands, and the western slopes were wetter than the eastern slopes, but the difference in rainfall between upland and lowland was least marked during the warm weather and most marked during the cold weather. Throughout the whole district, on the average, the rainfall decreased in intensity from January until April, increased from April to August, showed a drop in relative quantity for September, rose to a maximum in October, and then declined until December. The local relief of the Pennine uplift gave to the cotton towns their character-istic climate, and was the dominant factor which had made Lancashire supreme in the cotton industry. Mr. H. J. Bartlett read a paper on "The Relation between Wind Direction and Rainfall." This was a discussion of wind and rain records at the four observatories, Valencia, Aberdeen, Falmouth, and Kew, for the ten-year period 1901–10. It was shown that a large proportion of the total rainfall occurs with winds in the south-east and south-west quadrants, except in the case of Aberdeen, where the amount in the north-west quadrant was relatively high. The greatest amounts at Kew and Falmouth were with a south-west wind, respectively 22 and 28 per cent. At Aberdeen the south-east wind brought the highest amount, 20 per cent.; while Valencia received 30 per cent. with south, 20 per cent. with south-east, and 15 per cent. with the south-west wind during the year. At each observatory there were two months during the year when the proportion of rain occurring normally in one or more quadrant diminished considerably. For Valencia, Falmouth, and Kew this feature was strongly marked in June and September, while for Aberdeen, where it was less obvious, the months were May and November. Mr. E. H. Chapman also read a paper on "Barometer Changes and Rainfall: A Statistical Study."

## NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

*(From our own Correspondent.)*

### Rheinland-Westphalia.

CHANGES of any moment cannot be reported from the iron and steel producing districts of Rheinland-Westphalia. A quiet business is being done generally, both raw and finished iron being in slow demand. Very few contracts of weight have been placed in the course of the past week, consumers having previously placed their orders for the third quarter. The Siegerland Iron Ore Convention has reduced raw spathose iron ore and roasted ditto. M.5 p.t. for next quarter's consumption, raw spathose iron ore now standing at M.12.10 p.t., as compared with M.12.60 p.t. previously, while roasted iron ore is sold at M.18.50 p.t., as compared with M.19 p.t. before. Quotations for all iron and steel articles as well as for pig iron have remained unchanged. Foreign orders are very keenly competed for and prices continue depressed in consequence. Scrap iron is exceedingly dull. A marked decrease was felt in the demand for railway material and for sectional iron. Recently a contract for supplies for three years was entered into by the State Railways; prices are M.4 and M.4.50 p.t. lower than previously. A little more animation was noticeable in the bar trade, both as regards home and foreign demand. Export quotations have slightly improved, M.85 to M.86 p.t. being quoted for merchant iron, while for inland consumption prices vary between M.95 to M.96 p.t. free Oberhausen. The inquiry for sheets has also improved during the week, and some mills can boast of being quite briskly engaged. For plates only a moderate inquiry comes in and quotations remain low, the Rhenish-Westphalian mills quoting M.100 to M.102.50 p.t. for common steel plates, while medium sorts realise M.103 to M.105 p.t. The Siegerland mills sell a little below these rates. Sheets have been tending upwards recently, good qualities fetching from M.117 p.t. to M.121 p.t. Boilermaking material of 5 mm. and more stands at M.110 to M.112 p.t. The business in gas and water pipes is dull, for consumers and dealers have been buying pretty freely, and at exceedingly low rates, for some time past; prices are stiffening a little now. The business in wire and wire articles keeps quietly steady. The Drawn Wire Convention has been prolonged provisionally until October this year.

### Production of Pig Iron.

According to official accounts given by the Union of German Iron and Steel Makers, the output of pig iron in Germany, including Luxemburg, was, for May this year, 1,607,211 t., compared with 1,534,429 t. in the month before, and with 1,643,069 t. in the same month last year. Output per working day in May this year was 58,845 t., as compared with 51,147 t. in the month before, and with 53,002 t. in May last year. Production in the different sorts of pig iron has been as follows:—Foundry pig, 280,527 t., as compared with 311,361 t. in May, 1913; Bessemer, 28,712 t., as compared with 29,406 t.; basic, 1,047,494 t., as compared with 1,049,524 t. in May last year; steel and spiegeleisen, 209,182 t., as compared with 207,227 t. last year; forge pig, 41,296 t., as compared with 45,551 t. in May last year.

### Coal in Germany.

Regarding the German coal market, little of interest can be reported, house coal as well as engine fuel meeting with fair request; in coke also a good business was done during the week.

### Austria-Hungary.

The iron and steel industries are only moderately employed; prices are rather well maintained, however, at least for inland sales. Brown coal and pit coal sell regularly at remunerative prices.

### Quiet Tone in France.

Accounts regarding the iron and steel trade continue unsatisfactory. Only in war material have plenty of orders come in; the motor car department is well engaged, and there has been increasing demand reported for agricultural machines and for electric plant, but in all other departments reserve is shown by both makers and consumers. In the East Department the reduction in the prices for coke and also for basic has enabled the mills of the district to compete with more success on foreign markets. Stocks in pig iron are heavy, however, only those in foundry pig having decreased. In the Nord competition is so keen that 140f. p.t. for merchant bars can only be obtained with difficulty, and sales are reported to have been effected at 137.50 p.t. The tendency all round is downward. In the Loire Department the heavy industries are reported actively engaged owing to large orders for army and marine requirements having been placed; for finished iron and steel articles only a weak demand comes in. The Paris retail business shows want of life in all branches; 170f. to 180f. p.t. is quoted for merchant iron, 205f. p.t. for special sorts, 210f. p.t. for hoops, 220f. p.t. for girders, and 230f. p.t. for 3 mm. plates. The coal market in France is losing firmness in consequence of the slow trade in iron and steel; coke is also in weak request and production has been reduced nearly 30 per cent. Imports of coal increased considerably during the first four months of the year, 5,282,727 t. having been imported, as compared with 4,460,400 t. in the same period last year. England stands first with 3,308,500 t., Germany coming next with 991,492 t., compared with 657,200 t. last year, while the amount imported from Belgium was 902,359 t. Import of coke was 682,180 t. as compared with 432,680 t. last year. Imports in artificial coal rose from 266,400 t. to 314,301 t.

## AMERICAN NOTES.

*(From our own Correspondent.)*

NEW YORK, June 3rd.

SEVERAL large transactions in low-grade pig iron for cast iron pipe are held up because of the refusal of makers to accept 50 cents less than the lowest cut. Other kinds of pig are moving slowly at prices that allow the barest margin. Bidders on the New York tunnel contract refuse to name less than 1.20 dols. a ton above present prices, because of the chances of an advance during the slow and prolonged delivery involved. All lines of finished material are dull under 40 per cent. restriction from maximum output. The tabulation made for May for general construction material gives 95,290 tons reported. Probably 25 per cent. escaped notice. The larger foundries and engineering plants show lessening activity, but tin-plate leads everything, and more big orders are in sight. Nothing can stimulate business except, of course, an advance in freight rates, and Congress taking its violent hands off the throat of business. The entire business situation is peculiar. Capital is marking time. Numerous projected enterprises are choked off. Crop indications are the best. Freight traffic is heavy. Were the two obstructing influences to be removed, forward buying would be precipitated on a scale of magnitude that would advance prices generally. Rail exports promise well as measured by inquiries. Hazy conditions may clear up unexpectedly. In fact, there is an undercurrent of belief or expectation of a quick opening of demand, especially in heavy steel plates and shapes. Copper continues quiet. Domestic demand is not up to early June averages. Shaded quotations fail to attract large buyers. Leading producers maintain electrolytic at 14¼, though rumours are abroad to-day that some big business may be captured at 14.

## BRITISH PATENT SPECIFICATIONS.

*When an invention is communicated from abroad the name and address of the Communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 8d. each.*

*The date first given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete Specification.*

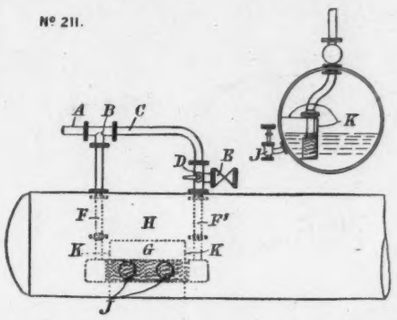
*Any person may, on any of the grounds mentioned in the Act, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of any Patent.*

### STEAM GENERATORS.

211. January 3rd, 1914.—IMPROVEMENTS IN REGULATING SUPERHEAT IN CONNECTION WITH STEAM GENERATORS, Babcock and Wilcox, Limited, of Oriel House, 30, Farringdon-street, London, E.C., and James Hermann Rosenthal.

The connection A from the superheater diverges at B into two branches, one branch C leading directly to the mixing valve D and thence to the main stop valve E, and the other branch leading to the mixing valve D by way of the attemperator G fitted within the boiler drum H. The attemperator G is of the form described in the specification of the prior Application No. 13,971 of 1913, being constituted by a long box into the side walls of which are expanded cross tubes and to the ends of which are coupled the limbs F F¹ of the second-mentioned branch of the superheater connection. The attemperator G is so positioned in relation to the feed-water inlets J that inflowing feed water will impinge thereon and is enclosed within a compartment formed by the wall of the drum and diaphragms or partitions K

Nº 211.



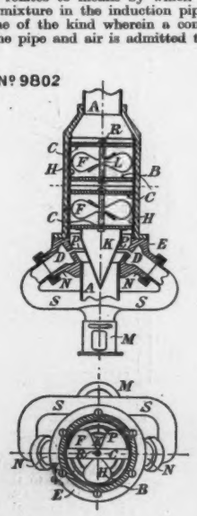

whereby the feed water is cut off from the main body of water, and the temperature within the compartment may be maintained considerably lower than that in the rest of the interior of the drum. At the junction of the branches C and F¹ is fitted the mixing valve D, adapted to control the communication between the branches C and F¹ and the main stop valve E. In the operation superheated steam is led by the connection A, and according to the position of the mixing valve D the ratio of the volume of steam flowing through the branch C to that flowing through the branch F F¹, including the attemperator, can be adjusted and thereby the degree of superheat regulated. In one extreme position of the mixing valve the entire volume of the superheated steam may be caused to flow through the branch C and thus to by-pass the attemperator, while in the other extreme position of the mixing valve the entire volume of steam from the superheater is passed through the attemperator.—*May 27th*, 1914.

### INTERNAL COMBUSTION ENGINES.

9802. October 25th, 1913.—IMPROVEMENTS IN CONNECTION WITH THE INDUCTION PIPES OF INTERNAL COMBUSTION ENGINES, Edward Samuel Charles Betteley "Sungate," Surbiton, Surrey, and George Hayton Baker, "Embleton," Surbiton, Surrey.

This invention relates to means by which additional air is admitted to the mixture in the induction pipe of an internal combustion engine of the kind wherein a cone is placed in a conical part of the pipe and air is admitted through openings

Nº 9802

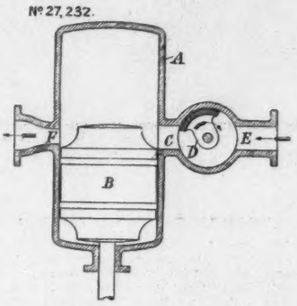



into the annular passage formed thereby. In the induction pipe A of an internal combustion engine is fixed a circular casting B, about twice the diameter of the induction pipe and tapering each end to the diameter of the induction pipe. One tapered end E is made detachable by means of a dished flange and cast integral with this tapered end is an air duct D, which is open to the annular passage formed by the cone K and the tapered end E, by means of a narrow slot P. The cone K is so proportioned that the area of the annular passage is kept approximately constant and equal in area to the area of the induction pipe. As an alternative method the duct D can open to the annular passage by means of a series of holes. The duct D is provided with one or more air inlets N, which are connected to an air regulator M by the pipe S. Into the circular casting B one or more circular cages H can be fitted, each containing a three-bladed fan F mounted on a long boss L, which is free to rotate on a fixed axle R carried by the cross pieces C. One of these cross pieces also carries the cone K. These fans, however, are not necessary features of this invention. The suction of the engine draws the gases from the carburetter up the induction pipe A, where they strike the cone K and are diverted into the annular passage before passing into the circular casting B, where they are diverted again into the induction pipe A by the second tapered end. If the air regulator M be open the suction of the engine will also draw in air through the slot P from the duct D, which, together with the gases, will pass to the engine. By these means the additional air is uniformly distributed over the whole of the gases from the carburetter, and as the additional air meets the gases in a narrow channel they become more thoroughly mixed, and this result is attained without reducing the area of the gas passage.—*May 27th*, 1914.

27,232. November 26th, 1913.—IMPROVEMENTS IN AND RELATING TO MEANS FOR CONTROLLING THE PORTS OF DOUBLE-ACTING TWO-STROKE CYCLE INTERNAL COMBUSTION ENGINES, the Maschinenfabrik Augsburg-Nürnberg, A.G., of Nürnberg, Germany.

In the example illustrated A denotes the cylinder of a double-acting two-stroke cycle engine which works with compressed air charges, B the piston, while the scavenging ports are indicated by C. D denotes a rotary slide valve, which is only provided with one single cut-off or sealing surface. The scavenging air is admitted at E. The rotary slide valve opens the scavenging ports only after the exhaust ports F have already been opened

Nº 27,232.



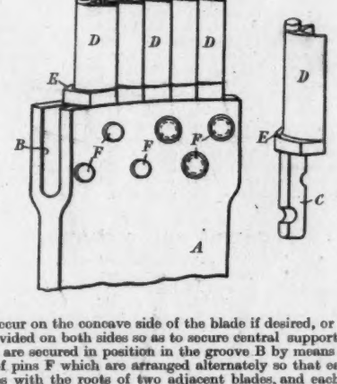

to some extent by the piston. During each of the to-and-fro movements—that is to say, during each stroke of the piston B—the rotary slide valve D makes a complete revolution, so that the latter works at double the speed of the engine. Although the rotary valve D closes the connection from the compressed air supply to the combustion chamber twice in each revolution, only one of these closings is effective, the other occurring at the time when the piston is covering the inlet port. Owing to the high circumferential velocity it is, moreover, rendered possible that the cross sectional passage areas are rapidly uncovered, i.e., opened, while, further, the simple construction of the slide valve presents disturbing changes in direction of the air current from becoming injurious.—*May 27th*, 1914.

### TURBINES.

22,148. October 1st, 1913.—IMPROVEMENTS RELATING TO STEAM TURBINES, Holberry Mensforth, of Westinghouse Works, Trafford Park, Manchester.

This invention has for its object to provide an improved method of attaching the blades or vanes to the edge of a disc by which they are supported. The turbine disc or wheel A is provided with a groove B having substantially parallel sides and adapted to receive the ends or roots C of the blades or vanes D. The roots are enlarged in the circumferential direction so that adjacent blades will be properly spaced apart. This enlargement is shown in the drawings at E as being on the convex side of the blade, this being preferable; but, obviously, the enlargement

Nº 22,148.



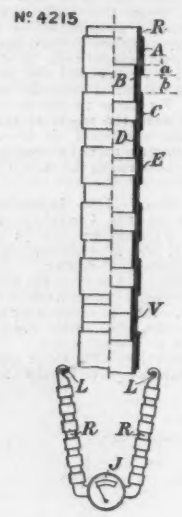

may occur on the concave side of the blade if desired, or it may be provided on both sides so as to secure central support. The blades are secured in position in the groove B by means of two rows of pins F which are arranged alternately so that each pin engages with the roots of two adjacent blades, and each blade or vane is held in place by two pins, one on each side. The pins may be screwed into the holes, but are preferably secured by riveting in a well-known manner as shown. As the securing pins F are placed in position from the sides of the disc their axes being parallel with the axis of the same, it will be clear that the invention is limited in its application to cases in which the turbine wheel carries one row of blades, as shown in the drawings, or in which at most two rows of blades are secured to the wheel.—*May 27th*, 1914.

### ELECTRICAL CONDENSERS.

4215. February 18th, 1914.—IMPROVEMENTS IN THE CONSTRUCTION AND OPERATION OF ELECTRICAL CONDENSERS OF THE RING TYPE, Hartmann and Braun Aktiengesellschaft, of 97, Königstrasse, Frankfort-on-the-Main.

A condenser constructed according to this invention comprises a tube R composed of insulating material and alternately covered and lined with external and internal metallic rings A B C D E, which overlap to a degree indicated by the dimension *a*, the lower portion of one ring and the upper portion of the next

adjacent ring thus forming the accumulating bodies of a condenser whereof the wall of the tube R constitutes the dielectric. Any convenient number of rings may be employed to suit the conditions of working, and several lengths of tubing may be connected by means of a socket joint formed by means of one of the rings, as shown at V. The condenser may serve directly to

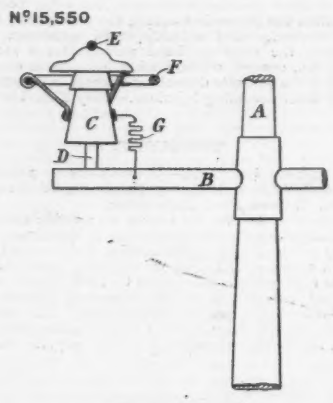



support the measuring instrument, the high-tension conductors I being connected to the ring condensers R, and the latter being in turn connected to the sides of the measuring instrument J. The advantages of this form of condenser are described fully.—*May 27th*, 1914.

## TRANSMISSION OF POWER.

15,550. July 5th, 1913.—IMPROVEMENTS IN AND RELATING TO PROTECTIVE DEVICES FOR ELECTRIC DISTRIBUTION SYSTEMS, *The General Electric Company, of Schenectady, County of Schenectady, State of New York, U.S.A.*

The object of the invention is to provide for the protection of transmission systems against the continuance thereon of certain unduly high voltages, if they are produced, and the prevention of oscillations of the energy thereon produced by the discharge of energy from or to one or more of the conductors of the transmission system. The mast A carries arms B for supporting the insulators carrying the conductors. The insu-

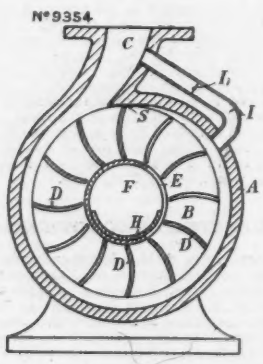



lator C is carried on a pin D attached to one of the arms of the mast. On this insulator is carried the conductor E. An arcing ring F is carried on the insulator C. Electrically connected to the arcing ring is the resistance G, which is also connected to the adjacent arm. The resistance member must be of such value hat a resistance of approximately the critical value is offered o a discharge from the conductor through the arcing ring and the resistance. The arcing ring is so placed that it is a part of the path of lowest resistance for any discharge which may take place from the conductor, or at least for any discharge which may take place from a given part of the conductor, the system as a whole being thus protected against discharges where their occurrence would be especially dangerous or undesirable. There is another illustration.—*May 27th*, 1914.

## PUMPING AND BLOWING.

9354. April 21st, 1913.—IMPROVEMENTS RELATING TO CENTRIFUGAL PUMPS, Siemens-Schuckertwerke G.m.b.H., of Askanischer Platz 3, Berlin.

The present invention has for its object to obtain a high pressure head with the liquid forced. A denotes the pump casing,

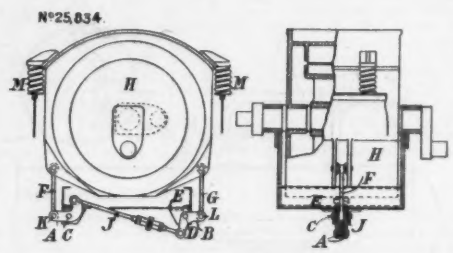



B the impeller, which is provided with forwardly inclined vanes D. The casing is so formed that the part indicated by S approaches close to the impeller, but there is a space between the impeller and casing opposite the entry opening E. The spacing of the casing relatively to the impeller for the remaining part of its circumference depends on the working conditions. In the drawing the wall of the casing from opposite entry opening to exit opening runs concentrically to the impeller. The cylindrically formed suction chamber F borders on the internal circumference of the impeller, and is provided with an entry opening E extending over only a portion of its circumference. In using the pump it is first filled with water and started up. Liquid is drawn in between the vanes as they pass the entry openings, and liquid also leaves the vanes, being propelled round the casing, its pressure increasing. The pressure is also stepped up in the diverging channel C in known manner. In order to regulate the pressure the extent of the suction opening relatively to the circumference can be varied, for example, by a throttle plate H, which can be moved around the tube F. The throttle can be made in the form of a slit tube concentric to the tube F and displaceable relatively to F. The pump pressure is also dependent on the width of the passage between impeller and casing immediately beyond the exit opening, so that a portion of the casing at the part S may be made displaceable or a compensating or return pipe I between the outlet and a part of the casing about opposite to the liquid inlet may be provided having a throttle device L. There are two other drawings.—*May 27th*, 1914.

## MOTOR CARS AND ROAD TRAFFIC.

25,834. November 11th, 1913.—IMPROVEMENTS IN ELECTRIC MOTOR-DRIVEN VEHICLES, Kalman von Kando, of Vado Ligure, Italy.

This invention relates to electrically driven vehicles in which an electric motor is connected to the driving wheels through a crank and connecting-rod, and has for its object to provide an improved means for connecting the motor to the frame of the vehicle in which it is supported. The improved device comprises two bell crank levers A B pivoted at C D respectively to the frame E of the vehicle, one end of each of the levers being connected through links F G respectively with the stator of the

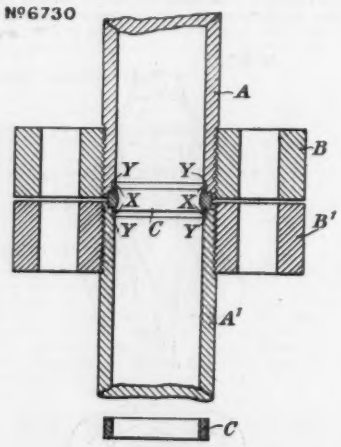



motor H. The free ends of the levers A B are connected by a link J and are so arranged that the levers are compelled to oscillate on their respective pivots in opposite directions, and by choosing correct proportions for the levers the vertical movement of the points K L where the links F G are connected may be caused, within limits, to be substantially equal. The weight of the motor may be supported from the frame of the vehicle by springs M. It will be clear without further description that the arrangement permits of both vertical and horizontal movements of the motor within certain limits, but that rotation of the stator is prevented.—*May 27th*, 1914.

## MISCELLANEOUS.

6730. March 17th, 1914.—IMPROVEMENTS IN AND RELATING TO PACKED JOINTS FOR PIPES AND TUBES, Fried. Krupp Aktiengesellschaft, of Essen, Germany.

This invention relates to packed joints for pipes and tubes of that kind in which a washer or ring of soft metal or other material is placed between the adjacent ends of two tubes which are to be connected together, and which packing is compressed when the ends of the tubes are forced towards each other by the connecting device. The object is to provide a packing of this class which will remain capable of use even at high pressures up to 1000 atmospheres and which is distinguished by ease of manufacture. The adjacent ends X of the tubes A and $A^1$ to be packed are flared out conically and provided with annular grooves which are open on the inside, and when the tubes are placed in contact form an annular recess of dovetailed cross



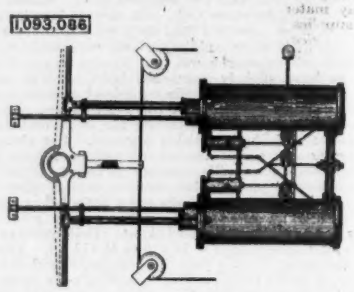

section. A sharp edge Y is therefore formed at the inner edge of each of the annular grooves. On to the ends of the tubes are screwed flanges B and $B^1$ in the well-known way. The packing device C, which is made preferably of copper or the like, forms a ring, which is of rectangular cross section prior to its insertion—see the lower drawing. Its external diameter is equal to the major diameter of the annular grooves, while its internal diameter is somewhat smaller than the minor diameter of the annular grooves. To pack the tubes A and $A^1$ the flanges B and $B^1$ are tightened up in the well-known way after the packing ring C has been laid in the annular grooves. When the flanges are tightened up the edges Y cut into the ring C, which ensures that this latter, under the action of the pressure caused by the drawing together of the flanges, bears against all the boundary surfaces of the annular grooves and completely fills them up. At the same time the inner part of the ring C is forced somewhat into the interior of the tube, thrusting itself in the manner shown over the conical part of the ends X of the tubes in the vicinity of the edges Y. Packing therefore takes place not only at the boundary surfaces of the annular grooves, but also at the parts covered up by the ring C of the conical part of the ends X of the tube, and the packing at this point is more effective the higher the internal pressure is.—*May 27th*, 1914.

## SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette.*)

1,093,086.—STEAM STEERING APPARATUS, *F. W. Thomson, Fort William, Ontario, Canada.—Filed February 19th*, 1913.

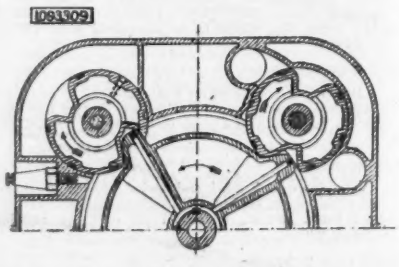
A yoke is secured to the rudder stock and the arms of the yoke are connected to the piston-rods of a prime mover comprising twin cylinders. Alternately steam reciprocated and fluid brake controlled pistons are arranged in the cylinders, and there are




means for operating the steam and fluid valves, and means for maintaining the amount of fluid in the brake. Guide rods extend from the ends of the cylinders, the pistons having sliding connection with these guide rods and being thereby maintained in parallel alignment. There are four claims.

1,093,309.—ROTARY INTERNAL COMBUSTION ENGINE, *G. Bourel, Paris, France.—Filed February 12th*, 1912.

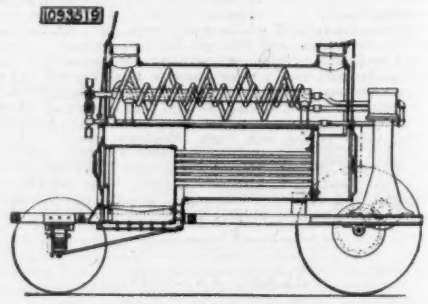
The casing is provided with a rotor cavity, and there are cavities for accommodating an inlet port drum valve and a compression controlled drum valve. A rotary disc is mounted on a concentric shaft and provided with teeth forming pistons dividing the rotor cavity into conduits. Rotary valves are provided with a plurality of peripheral cavities and segments, the valve




cavities being equal in number to the number of teeth for regulating the admission of the explosive mixture. Cranks are keyed to the axles of the rotary valves for actuating the valves at a positive ratio for movement of the rotary disc to arrange the cavities of the valves in operative relation to the teeth of the rotary disc. There are cam-driven rollers within cam grooves formed on the fly-wheel for controlling the cranks. There is only one claim.

1,093,519.—SUPERHEATER, *E. J. Akins, Moundsville, W. Va.—Filed November 29th*, 1912.

The inventor claims the combination with a boiler having a steam dome, of a pipe entering the dome and extending to an appreciable distance therein, a superheater coil connected with the pipe, and means for discharging steam from the superheater




coil, as well as means for receiving the exhaust from the superheater coil. An exhaust reheating pipe extends for substantially the full length of the dome for receiving the exhaust steam, and there is a pipe for discharging the steam to a second point of discharge. There are eight claims.

CONTRACTS.—The British Westinghouse Electric and Manufacturing Company, Limited, informs us that it has secured the contract for the extra high-tension switchgear, and also for the low-tension switchgear and connections, for eleven substations in connection with the London and North-Western Railway Company's North London electrification.—The contract for a double-inlet Keith reversible mine fan, to handle 400,000 cubic feet of air per minute at 6in. water gauge, to be installed at Nantgarw Colliery, South Wales, has been placed with the James Keith and Blackman Company, Limited.

THE INSTITUTE OF METALS.—Portsmouth has been selected as the place of meeting for the autumn conference of the Institute of Metals. The conference, which will be presided over by Engineer Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S., the President of the Institute, will be held on Thursday, September 10th, and Friday, September 11th, in the Municipal College, a number of papers being read each morning. In the afternoon of September 10th a visit will be paid to Portsmouth Dockyard, and there will be a dinner in the evening. On September 11th the afternoon function will consist of a luncheon at the Cowes works of J. Samuel White and Co., the works afterwards being inspected.

# 40-TON STE

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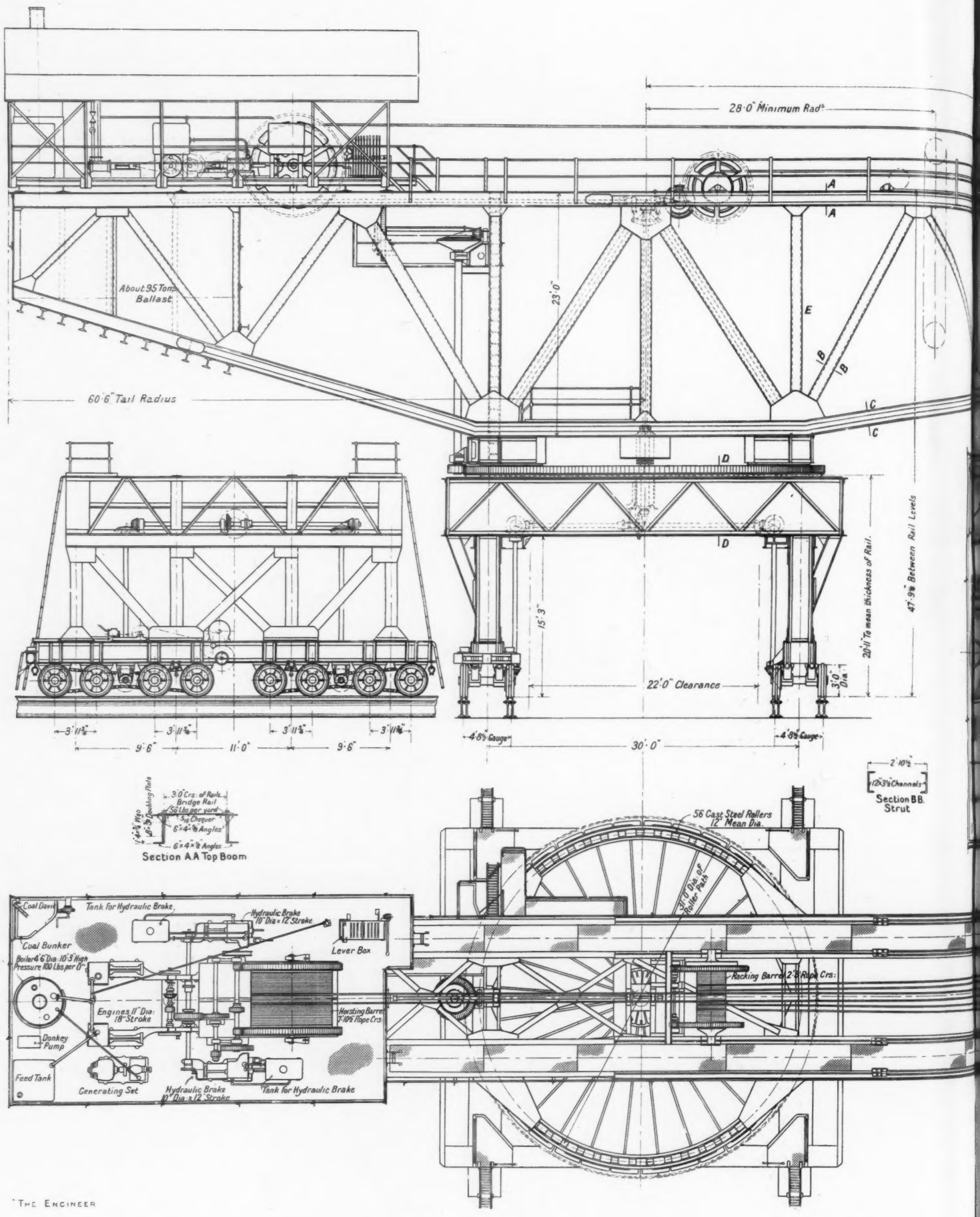
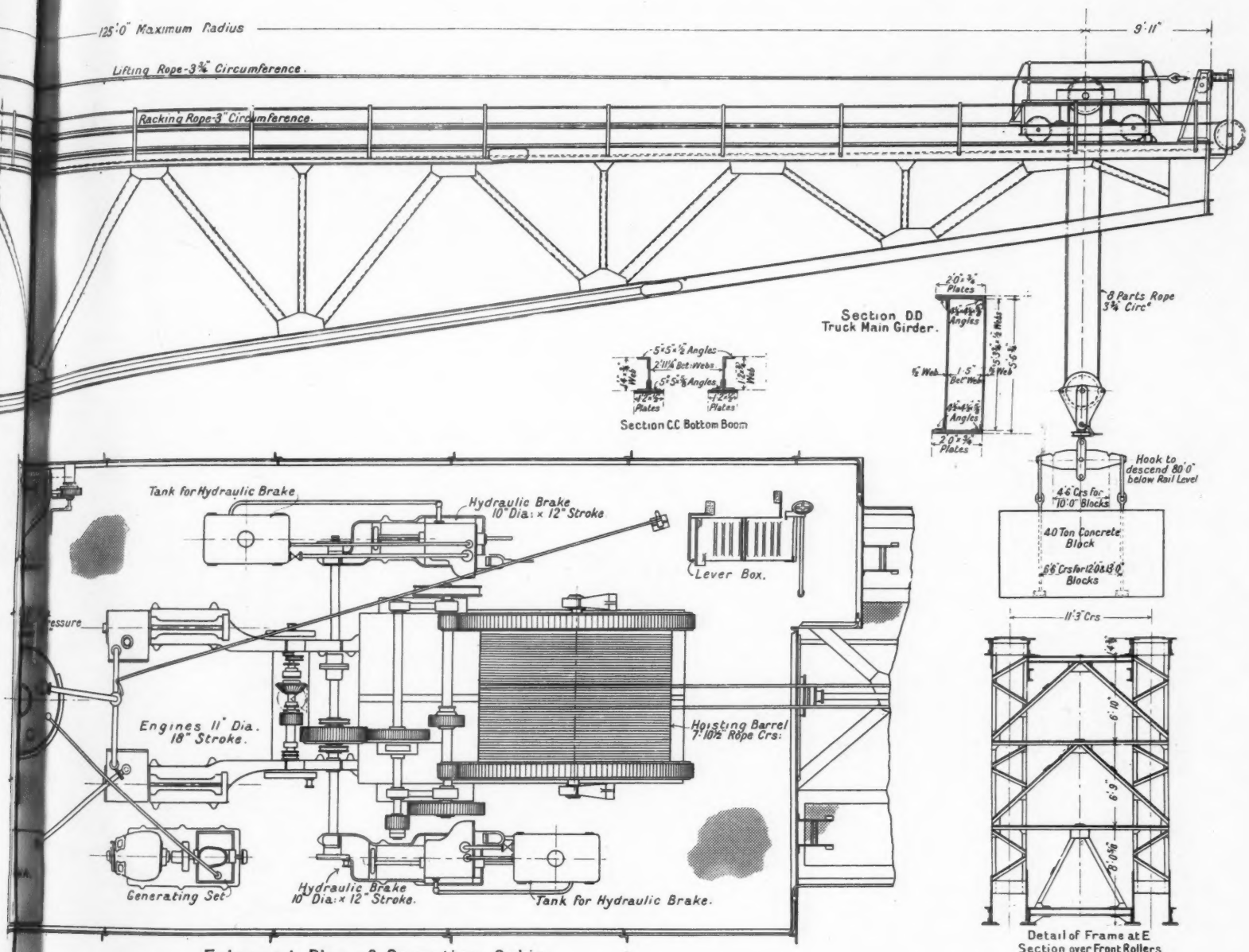


# N STE[illegible]ITAN CRANE

ERT AND [illegible]ED, BATH, ENGINEERS


125'0" Maximum Radius
9'11"
Lifting Rope-3¾" Circumference.
Racking Rope-3" Circumference.
Section DD
Truck Main Girder.
8 Parts Rope
3¾" Circ.
Section CC Bottom Boom
Hook to descend 80'0" below Rail Level
4'6" Crs for 10'0" Blocks
40 Ton Concrete Block
6'6" Crs for 20 & 18'0" Blocks
11'3" Crs
Tank for Hydraulic Brake
Hydraulic Brake 10" Dia: x 12" Stroke
Lever Box.
Engines 11" Dia. 18" Stroke.
Hoisting Barrel 7'10½" Rope Crs:
Generating Set
Hydraulic Brake 10" Dia: x 12" Stroke.
Tank for Hydraulic Brake.
Detail of Frame at E
Section over Front Rollers
Enlarged Plan of Operating Cabin
Scale of Feet
0 5 10 20 30 40 Feet

SWAIN SC

## SOME RECENT FRENCH LOCOMOTIVE PERFORMANCES.

By J. T. BURTON-ALEXANDER.

I HAVE been enabled to obtain some very interesting runs on the Paris, Lyons and Mediterranean Railway on its main Marseilles line, as well as on the line from Dijon to the Swiss frontier at Pontarlier.

On the 9 a.m. from Paris to Laroche, the first stop, with a load of ten coaches, weighing 338 tons and without a single vacant seat in the train, the work was interesting as our engine was not one of the new 4–6–2 class, but No. 2612, an old four-cylinder compound of the 4–6–0 class, and the load was about 25 per cent. in excess of that which these engines are supposed to haul at the booked speed of this train. We passed Villeneuve St. Georges, 8.9 miles, in 14 min. 35 sec., and Melun, 27.3 miles, in 36 min. 30 sec. at the very reduced speed of 18 miles an hour—this slack has been in force since the terrible accident of last year—but our speed had risen to 47 miles an hour before we reached the top of the rise of 1 in 220 and 1 in 250 before Fontainebleau, while the steam pressure in the low-pressure cylinders was 60 lb. per square inch. We passed Fontainebleau, 36.6 miles, in 49 min. 35 sec. from the start; Montereau, 48.4 miles, in 62 min. 15 sec., our speed having risen to 65.2 miles an hour before this station Sens, 69.7 miles, was passed in 86 min. 15 sec., and we stopped in Laroche, 96¼ miles, in 116 min. 30 sec. gross, or 113 min. 30 sec. net, only a loss of 1½ min. But there is a further point I ought to mention. Owing to this not being the regular engine, the coal was not that which is generally supplied for the fastest work, but contained a large quantity of slack, so that after Fontainebleau we suffered from lack of steam, the pressure dropping, and on several occasions we had to close the regulator, owing to the slack bird-nesting and blocking the tubes. However, the driver was able to dislodge a portion of this crust by dropping his reversing lever into full gear at high speed for a short time. This fact only adds to the remarkable nature of the run, the more remarkable in that this engine has no superheater. The same engine, when new in 1905, gave me a remarkable run from Laroche to Paris on the up Cote D'Azur *rapide* with a load of seven coaches, or 228 tons. We passed Sens in 29 min. 5 sec. in spite of a long permanent way relaying slow which lost us 3 min.; Montereau, where we slowed to 25 miles an hour, in 48 min. 5 sec.; Fontainebleau in 60 min. 30 sec.; and Melun in 68 min. 55 sec. Between Brunoy and Villeneuve we had no less than three stops and one slow which delayed us at least 12 min., so that we passed Villeneuve in 97 min. gross, and stopped in Paris, 96¼ miles, in 108 min. 15 sec. gross, or 93 min. 15 sec. net. A magnificent performance, as there was a very high side gale from the west.

I had a very good run with the day express which runs from Marseilles to Bordeaux during holiday time, when the load from the former station was no less than twelve coaches, weighing 394 tons, and the engine No. 2695, a 4–6–0 compound superheater. Starting from Marseilles our speed had risen to 45 miles an hour before passing L'Estaque, 6.4 miles, at a walking pace in 13 min. 35 sec.; Rognac, 16.8 miles, in 27 min. 45 sec.; Miramas, 32.8 miles, in 46 min. 5 sec., where again our speed was reduced to 10 miles an hour; and we stopped in Arles, 52¼ miles, in exactly 70 min. gross, or 63 min. 20 sec. net, with a maximum speed of 63.9 miles an hour. After Tarascon we climbed the 4¼-mile bank of 1 in 135 at a steady 35 miles an hour, and finally stopped in Nimes, 16¾ miles, in 23 min. 40 sec.; from that point, with the same load, we ran from Nimes to Lunel in 20 min., but on to Cette the running was not so good, as speed was reduced on several occasions for relaying purposes.

From Marseilles I came by the day *rapide* from the Riviera, which had a load of eight coaches, or 276 tons. As far as Avignon our engine was No. 6171, a four-cylinder superheater, 4–6–2 with a boiler pressure of 171 lb. per square inch. We passed L'Estaque, 6.4 miles, in 11 min. 50 sec. at a walking pace; Rognac, 16.8 miles, in 25 min. 15 sec., at 57 miles an hour; Miramas, 32.8 miles, in 41 min. 10 secs., again being slowed for the relaying and rearranging of the lines, but our speed before had risen to 70 miles an hour at Berre; Arles, 52¼ miles, in 64 min.; Tarascon South Junction in 71 min. 10 sec., and we stopped in Avignon, 74.7 miles, in 86 min. 20 sec. gross, or, deducting the slows, 81 min. net. There was a very strong mistral blowing which considerably hindered our running. The average steam pressure was about 160 lb., and the steam temperature 300 deg. Cent. In 1905 with a load of seven coaches, or 227 tons, and C–154, a big wind cutter 4–4–0 compound, from Marseilles, we passed L'Estagne in 10 min., our speed having risen to 55.9 miles an hour; Rognac in 20 min. 30 sec., at 66.4 miles an hour; Miramas in 36 min. 25 sec.; Arles in 59 min. 10 sec., in spite of a relaying slow which delayed us at least 3 min., or only 56 min. 10 sec. net., at a speed of 64.4 miles an hour; Tarascon South Junction in 67 min. gross, or 64 min. net; and stopped in Avignon in 84 min. gross, or 81 min. net. This included a service slow to 20 miles an hour at the South Junction, Tarascon.

From Avignon, with the same load, our engine was No. 6175, of the same class, but for an increased steam pressure of 200 lb. per square inch, and we continued in a furious gale of wind as far as Valence. We passed Orange, 17.3 miles, in 21 min. 45 sec.; Bolene, 29.2 miles, in 33 min. 35 sec.; Montelimar, 49.6 miles, in 54 min. 55 sec.; Loriol, 64.5 miles, in 70 min. 20 sec.; Portes, 73½ miles, in 78 min. 50 sec.; and stopped in Valence, 77½ miles, in 83 mins. 15 sec. The speed had varied between 54 and 62.1 miles an hour, with a maximum of 65.2 miles per hour near Etoile, where the wind had less power. The steam pressure was steady at 190 lb. per square inch, and the steam temperature varied between 330 deg. and 340 deg. Cent. From Valence the wind lost its great power, and as the engine was steaming well we hoped to make up our late start of 8 min. before Lyons. Starting very smartly, we passed Tain, 11.7 miles, in 13 min.; St. Vallier, 20.3 miles, in 21 min. 25 sec.; St. Rambert, 28 miles, in 29 min. 50 sec.; Vienne, 46.3 miles, in 45 min. 20 sec.; Chasse, 52.8 miles, in 51 min.; St. Fons, 62¼ miles, in 59 min. 40 sec.; and stopped in Lyons, 65.8 miles, in 64 min. 10 sec. The engine had steamed splendidly, and the fireman never touched the fire once from Avignon with any of his irons, while the steam temperature was steady at 335 deg. Cent. The speed never dropped below 58.9 miles an hour, and beyond St. Rampert ranged between 64 and 66 miles an hour, but before Vaugris it touched 71.4 miles per hour, and at Vienne and Chasse was 67.2 miles per hour. This was a remarkable performance, as our average speed from Valence to Lyons was 61.7 miles an hour on a line that ascends the river Rhone.

From Lyons to Dijon the engine was No. 6211, a new compound superheater. We had a very long service slow on the bridge across the Saone, outside the Perache Station, which delayed us quite 4 min., so that we only passed Lyon-Vaise, 2½ miles, in 8 min. 50 sec.; St. Germain, 12½ miles, in 18 min. 15 sec.; Villefranche, 21 miles, in 25 min. 50 sec.; Belleville, 29.8 miles, in 34 min.; and stopped in Macon, 44.1 miles, in 48 min., or 44 min. net. Our speed varied between 62.1 and 67.3 miles an hour. At Macon we found that the steam heating pipes of one of the coaches was broken, and this caused us to leave 4 min. late. We rapidly attained a speed of 67.3 miles an hour, and passed Tournus, 19.8 miles, in 19 min. 20 sec.; Chalons, 35.6 miles, where there is a service slow to 25 miles an hour, in 34 min.; our speed having previously reached the maximum of 74.1 miles per hour; Chagny, 45½ miles, in 46 min. 5 sec.; and stopped in Dijon, 77.8 miles, in 78 min. 20 sec., 2½ minutes early. The engine was not the one chosen to take this train, and so had indifferent coal; in fact, there was a lot of slack for the last 20 miles into Dijon, but the steam pressure kept steady at about 200 lb., and the steam temperature was between 315 deg. and 320 deg. Cent.

From Dijon I ran up to Pontarlier to see these big 4–6–2 engines working loads of, in winter, 220 tons, and in summer 257 tons, unaided up continuous banks with curves and tunnels of 1 in 50. I think it will be allowed that driving wheels of 6ft. 8in. diameter are not usually associated with gradients of 1 in 50 for any considerable distance, but the proof of the soundness of the theory that big driving wheels are not a disqualification for hill climbing in themselves must be held to be proved from the excellent results that these engines have given on this section of the line. The load these engines are supposed to take up the bank without piloting is 197 tons, but they actually take, as I have said, in winter 220 tons and in summer 257 tons, without assistance except in exceptional weather or in snow. On the day I went from Dijon the load was eight coaches, or 266 tons, as far as Dole, and seven, or 219 tons, from there on. The engine was No. 6183, a four-cylinder non-compound superheater with 200 lb. boiler pressure.

We left Dijon 12 min. late, and were slowed at the junction at Perigny, 1 mile from the start, but we passed Neuilly, 5.5 miles, in 7 min. 20 secs., speed having risen to 74.1 miles an hour; Auxonne, 19¾ miles, in 18 min. 50 sec.; and we stopped in Dole, 28.6 miles in 27 min. 30 secs., our speed having never gone below 65.2 miles an hour up the 6 miles of 1 in 200 and 1 in 150 before that station. From there our speed at kilometre post 365 had risen to 68.3 miles an hour, and only fell to a minimum of 55 miles an hour up the subsequent 1 in 100, and we passed Grand Contour, 5.9 miles, in 6 min. 30 sec. from the Dole start; Arc Senans, 15.5 miles, in 14 min. 40 sec., our speed having been between 70 and 74 miles an hour, and climbed the 1 in 100 to Mouchard so smartly that we stopped in that station, 19.8 miles, in 18 min. 40 sec., our minimum speed up the bank being 58.9 miles an hour, the 48.4 miles from Dijon having only taken 46 min. 10 sec. At Mouchard we were informed that snow had fallen in the hills, but decided to try the climb to the summit without any pilot. From Mouchard you start on about half a mile of 1 in 100 and then 1 in 50. We rapidly gained speed, and passed Mesnay Arbois, 6.5 miles, in 12 min. 30 secs.; Pont d'Hery, 12 miles, in 21 min. 45 sec.; and stopped in Andelot, 15 miles, in 23 min. 35 sec. Our speed up the 1 in 50 was a steady 34 miles an hour, with 70 per cent. admission to the cylinders, 140 lb. of steam in the steam chest, and 340 deg. Cent. steam temperature. The boiler maintained the water level satisfactorily and the steam pressure kept steady. On leaving Andelot we found snow on the rails, but we climbed the subsequent gradient to Boujeailles at a speed of 31 to 34 miles an hour, passing La Joux, 4.3 miles, in 7 min. 40 sec., and stopped at Boujeailles, 8 miles, in 13 min. 50 sec., our speed on the 1 in 100 before that station having risen to 46 miles an hour. Our average speed was 35 miles an hour from Mouchard, start to stop in both cases. On from Boujeailles to Pontarlier, the run was spoilt by the signals being snowed up by the storm that had raged before we climbed the bank. This run was made in January, and the fact of the signals being snowed up shows that there was snow on the rail for our climb. The engine steamed well, though the wire drawing must be noted, as these engines appear decidedly over-cylindered, and it is, I believe, proposed to line up those of one engine. On the return journey the speed is limited down the 1 in 50 to 52 miles an hour, and the brake used in the descent is the "moderable" system of a former locomotive superintendent, M. Henry. From Mouchard, with 243 tons, we ran to Dole in 19 min. 30 sec., and then on to Dijon, with the increased load of 283 tons, in 30 min. 40 sec., in spite of a wild snow storm and gale.

Returning to Paris from Dijon to Laroche by the day Riviera express due to leave Dijon at 6.28 p.m., we had a load of nine coaches, or 335 tons, and engine 6183, a four-cylinder superheater with 200 lb. steam pressure. Unfortunately as the train was wired forward as very late, and the Swiss train due to leave at 6.50 left in front, but the Riviera *rapide* had made up time, consequently the Swiss train had hardly left Dijon before the *rapide* arrived. This was unfortunate, as it prevented our having a clear road. However, starting smartly we rapidly accelerated, and passed Velars, 5.4 miles, in 9 min. 35 sec., at 40 miles an hour; Blaisy Bas, 16.4 miles, in 22 min., the speed on the rising gradient of 1 in 125 before the tunnel having risen to just 50 miles an hour; Les Laumes, 35.8 miles, in 41 min. 5 sec., the speed down the hill having been carefully restricted to the maximum allowed, 62.1 miles an hour; Nuits, 55½ miles, in 56 min. 20 sec., but we were stopped at Ancy, a distance of 59½ miles from Dijon, in exactly 60 min. 30 sec. from the start, a very fine performance, as the speed from Les Laumes to Ancy was practically 74.6 miles an hour continuously. Starting again, we had a very long relaying slow in the tunnel before Tanlay, but we passed Tonnerre, 72·6 miles, in 78 min. 50 sec., and were again stopped by signals 88 min. 30 sec. from the start. However, we passed St. Florentin, 88 miles, in 95 min. 50 sec., and stopped in Laroche, 99 miles, in 105 min. Our speed had been, apart from the second stop, steadily 74.6 miles an hour. The weather was a violent westerly gale, with blinding snow squalls, which enhances the value of the work done. Up the hill to Blaisy the steam pressure in the steam chest was 145 lb. The steam temperature varied between 320 deg. and 340 deg. Cent., and the engine steamed well, maintaining most satisfactorily the water level in the boiler. When running fast on to Laroche, we had plenty of steam and water. There is no doubt that the net time of this run is between 91 min. and 92 min. for the whole distance. In 1905, with one of the then new 4–6–0 compounds on this same train, but the lesser load of only 227 tons, we passed Blaisy from Dijon in 23 min., Les Laumes in 41½ min., Nuits in 60 min. 40 sec., and then a coupling broke near Ancy, which caused great delay, but from Ancy to Laroche we only took 37 min. 15 sec. for the 39¼ miles, a very fine performance. I am hoping this autumn to get some further work on the 4–6–2 engines, with the much heavier loads, which run up to 450 tons, on the Swiss trains in summer and autumn.

I have been enabled to obtain several very interesting runs on the Nord. The first was on the new 4.30 service from London. I was unfortunate on the English side, as a relief train from Charing Cross considerably hindered us and quite prevented any attempt to keep time, and as a result we were 37½ min. late out of Calais. The load was the light standard one of five coaches, or 200 tons, and the engine 2.644 fitted with a superheater. We passed Fontinette in 5 min. 40 secs., Caffiers in 17 min. 5 sec., Boulogne Tintilleries in 30 min. 25 sec., Etaples in 47 min. 30 sec., and stopped in Abbeville in 77 min. 15 sec. Starting again, we passed Longpré in 12 min. 10 sec., Amiens in 28 min. 35 secs., but were constantly checked by signals, so that we only passed Longueau in 35 min. 15 sec., a loss of 3½ min., Gannes in 58 min. 50 sec., Cleremont in 70 min. 20 sec., and Creil in 80 min. 50 sec., in spite of a very severe slow for the Tergnier Junction which delayed us 3 min. Survilliers was passed in 95 min. 50 sec., St. Denis in 109 min., and we stopped in Paris, Nord, in 114 min. 15 sec. gross, or 108 min. 45 sec. net., our total net running time from Calais being only 186 minutes. This was remarkable work, in spite of the light load, for the Nord.

My last run on the 9.50 to Calais, was with No. 3.1157, a 4–6–2 compound superheater engine, which had been modified since last I had a run with her. The load was eleven coaches, or 354 tons, and the weather was misty near Paris, with a very slippery rail, while from Creil on to and after Etaples we had a most furious side gale with squalls of rain, quite one of the wildest days I have seen. We passed Survilliers in 21 min., our minimum speed being 58 miles an hour, with 45 lb. pressure in the low-pressure cylinder, with a steam temperature of

310 deg. Cent.; Creil in 32 min. 30 sec., speed having risen down the bank to 74.6 miles per hour before we shut off steam; Cleremont in 43 min. 10 sec., speed having risen to 63.4 miles an hour; and Gannes in 57 min. 5 sec., while the gale at the top brought our speed down to 53 miles an hour, though we still had 40 lb. pressure in the low-pressure cylinders and 300 deg. Cent. steam. Speed downhill ruled moderate, and we passed Amiens in 82 min., Longpré in 99 min. 35 sec., and stopped in Abbeville in 110 min. 30 sec. From Abbeville we felt the full force of the gale, and took 10 min. 50 sec. to pass Noyelles. Our speed up the 1 in 200 was 55 miles an hour. We passed Etaples in 32 min. 5 sec., our speed having varied between 65.3 and 67 miles an hour; Hesdigneul in 43 min. 30 sec., the minimum speed up the bank being 48 miles an hour; Boulogne Tintilleries in 50 min. 5 sec., speed being reduced to 37 miles an hour for a service slow over a bridge, while in the tunnel after the station the slipping was very bad indeed; but we passed Caffiers in 66 min. 20 sec., never dropping below 47 miles an hour at the top; and we stopped on Calais Pier in 79 min. 5 sec. from Abbeville. There is no question as to the extreme efficiency of these relatively small 4–6–2 engines and their remarkable steaming qualities, as from Abbeville our boiler pressure was steadily at blowing-off point, our water level was well maintained, though we only had slack coal and briquettes to fire with, and the variable exhaust was very nearly open. I believe further modifications are being carried out in the valve gear with a view to improvement.

I am informed that the new 2–8–0 on the Nord and the new 2–8–2 on the P.L.M., goods engines, are giving great satisfaction. These latter engines will be exhibited at the Lyons Exhibition this summer, together with a new passenger tank engine.

I must thank Messrs. Marechal and Asselin, Ingenieurs en Chef du Materiel and Traction of the P.L.M. and Nord respectively, for the facilities they have afforded to enable me to make these observations.

## THE FURKA RAILWAY.

*(From our Swiss Correspondent.)*

A NEW Alpine railway, the Furka line, from Brigue to Disentis, is to be opened on the 30th of this month.

Fig. 1—ROUTE OF THE FURKA RAILWAY

The line begins at the old Valaisan town of Brigue, now an important railway junction, where the lines coming up the Rhône Valley from Lausanne and that from the Lötschberg Tunnel converge and join up with the Simplon Tunnel line. The station of the Furka line adjoins those of the Federal and Lötschberg Railway.

After leaving Brigue—see Figs. 1 and 2—the Furka Railway runs through the long Upper Rhône valley, locally known as the Vallée de Conches, or, in German, Gomsertal, which sometimes narrows almost into a gorge and at other times broadens out almost into a plain. The line is partly on the adhesion and partly on the rack system, and it has for about 20 miles gradients of between 1 in 14.3 and 1 in 9. A profile is given in Fig. 3. It is of metre gauge, and is to be worked by steam traction. The chief reason for the choice of steam rather than electricity as motive power was that the latter would have proved too expensive. It would have cost nearly £200,000 more to install it than the former. Moreover, owing to the altitude of most of the new line, and the frequency of avalanches along it in spring, the current would probably often have been interrupted. Then, again, the fact must be taken into account that the railway will not probably be worked for more than four months in the year at most, for, although it passes a number of small and a few larger villages, such as Andermatt and Fiesch, it will be very largely a tourist line only. At any rate, it will depend for its revenue almost entirely on tourist traffic. Its cost is estimated at 38,000,000f.—say, £1,520,000—the capital having been entirely subscribed by French investors.

The highest point reached by the Furka line is at the Furka station, which is close by the portal of a tunnel which is driven under the Furka Pass. The elevation of the Furka Station is 2163 m., or 7095ft. The railway before it enters the tunnel runs very close indeed to the terminal face of the Rhône Glacier.

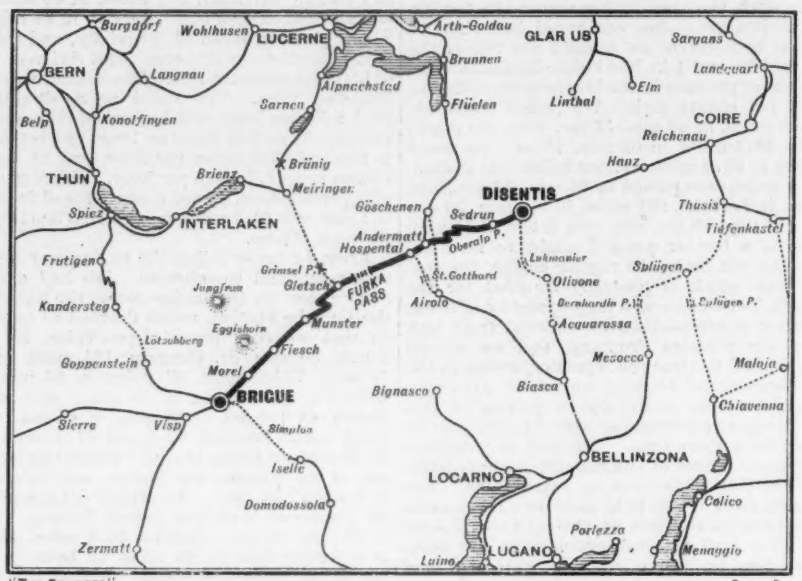



Fig. 2—THE FURKA RAILWAY AND NEIGHBOURHOOD

will be made for some time yet, though another small line which will feed the Furka is already far advanced towards completion—the Schöllenen line, from Andermatt to Göschenen, on the St. Gothard system. The tunnel in this short stretch of railway, which is only about 2½ miles long, and on which electric traction is to be used, has just been pierced. Its length was not quite 230 yards, but the dynamite alone for blasting away the excessively hard rock through which it runs cost £840.

This summer the Furka line will be opened only from Brigue to Gletsch. It was hoped to open it to Disentis, but owing to the trouble in piercing the Furka Tunnel this has proved impossible. Apparently some miscalculation was made as to the best point at which to commence the piercing of the tunnel. Boring was first begun at one point, but it was found impossible to proceed owing to the utter lack of

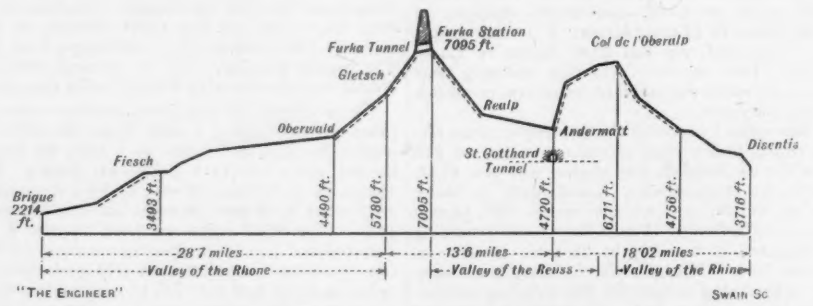



Fig. 3—PROFILE OF THE FURKA RAILWAY

The route of the line and the position of the south portal of the tunnel are shown on one of the views on page 703. After leaving the Furka Tunnel the line descends to two small and ancient villages, Realp and Hospenthal, before reaching Andermatt, while beyond Andermatt another heavy gradient is encountered, and a tunnel, the second in the line—the first being at Grengiols, see Fig. 4—by which the train mounts in a spiral to the Oberalp Pass, has had to be constructed. The height attained by the line is again considerable, at this point being 6665ft., after which it descends to a level of 3716ft. at Disentis Station. Here it connects with the Rhaetian railway system, which connects the Engadine with Chur, or Coire, at which place connection is again made with the Swiss Federal lines.

The valley descending from the Oberalp Pass to Disentis is very wild, and but thinly populated, the villages being small and some distance apart. As a cohesion in the substance of the mountain, and an attempt was made at another point not far distant. Here also serious difficulties are now being encountered, and boring is being carried on in very difficult material. In one of the views on page 706 the first and second points are shown at A and B respectively.

On such a line as the Furka progress is very slow, because of the short period during the year when it is possible to work. The summer is very short, and, except in summer, when the snow has melted, work is out of the question. Snow lies till quite the end of May, and often till early June, rendering earth work impossible, while in September it has often begun to fall for the winter. The Italian workmen, who are, of course, employed on this line, as on all others in Switzerland, are inclined to take to flight at the first sight of snow. Last July 3500 Italians were occupied on the line, and during the months when work was possible it went on very rapidly. In the September

tourist line the Furka Railway, which is the longest Alpine railway in existence, 61 miles, will, of course, possess much interest, for it has opened up a hitherto little known and remote part of Switzerland, and one, moreover, in which communication has been slow and not altogether convenient. But it is certainly not upon the local population that the enterprise must depend, whether in the Upper Rhône Valley or in the Andermatt or Reuss Valley, or in the valley of the Rhine leading down to Disentis.

The contract for the building of the Furka line was awarded in 1908 to the Société des Constructions des Batignolles. The Furka Railway Company has also another concession—that for a line from Gletsch to Meiringen over the Grimsel Pass, in order to connect with the Brünig line and the Bernese Oberland. No beginning, however, has been made with the building of this line, nor does it seem likely that any

of 1913, indeed, the rails had been laid from Brigue as far as Oberwald, a distance of over 26 miles, so that service trains could be run. Another difficulty arises from the impossibility of getting material, such as wood for scaffolding, cement, &c., where it is wanted, except at certain times of the year, means of communication being so few and distances so great.

Between Brigue and Disentis the line has twelve tunnels, 2 miles 1055 yards long, taken altogether. The longest, the Furka Tunnel, runs directly under the Furka Pass, coming out at an altitude of 7095ft., while, besides the tunnels, there are 50 bridges and viaducts, more than twenty being 165ft. or more in length. The engines come from the Schweizerische

FIG. 4—ENTRANCE TO LOOP TUNNEL AT GRENGIOLS

Lokomotivfabrik, Winterthur, and conform to the usual Swiss regulations for narrow-gauge engines. They are able to pull 43 tons. Flat-bottomed rails weighing 55 lb. per lineal yard and steel sleepers are used.

From Brigue to Gletsch a slow train will take 2¼ hours, and an express 2 hours, or rather less. Carriages of the Rhaetian Railways can be run over the Furka line, and it is intended, when the entire line is open, to run through services daily in summer from St. Moritz to Brigue and *vice versâ*.

The Furka Pass, of course, is well known to tourists on account of the beauty of its scenery and the rare profusion of its wild flowers, though it is one of the least historic passes in the Alps. Fiesch, one of the principal stations between Brigue and Gletsch, is also well known, as a pretty village in itself and as being the point of departure for the pleasant summer resort of the Eggishorn, for the Märjelensee, and the Aletsch Glacier. Andermatt, of course, is now frequented in the winter for sports as well as in summer, and Disentis is one of the oldest places in Switzerland, with a monastery, the foundation of which dates back to 640, and with mineral springs. The side valleys off the Upper Rhône Valley are chiefly inhabited by a toiling pastoral population, which still carries its hay, its scanty corn, and its cheeses on its back, and, it is to be feared, is not very likely to send them by rail even now that it is in a position to do so. It is a population, in short, that has much ado to live, and that would not live at all did it not utilise every particle of soil and every blade of grass, even in the most inaccessible places. Many villages have actually become depopulated, and it remains to be seen whether the new line will tend to bring fresh prosperity to a district from which the best blood now emigrates to lands where conditions are less harsh and the struggle for life less strenuous.

## THE PORT OF ANTWERP.

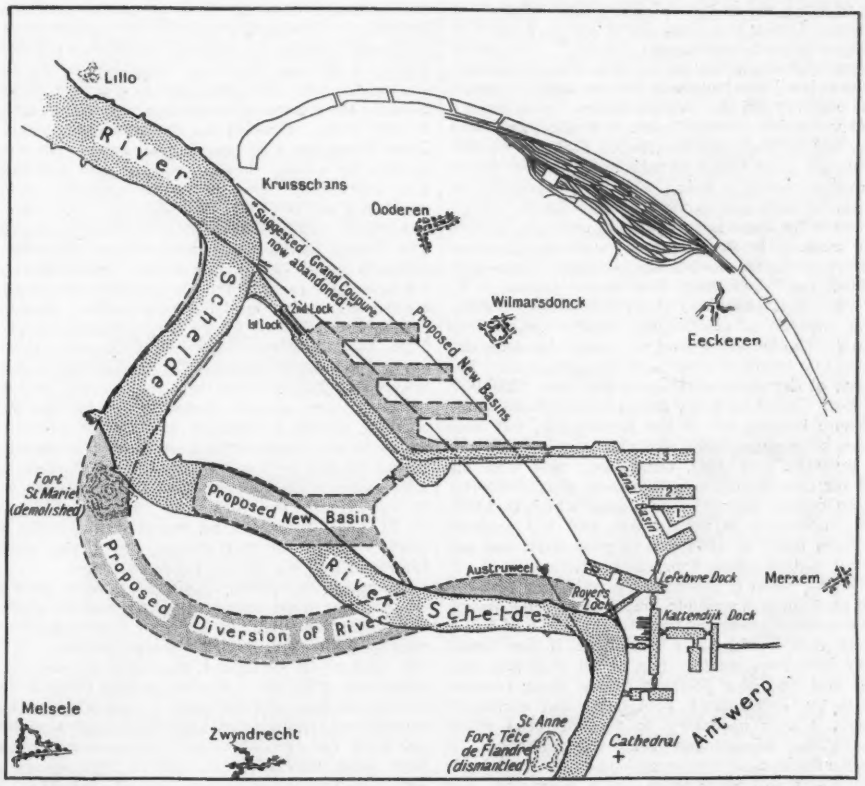
ANTWERP, as a port for loading and discharging sea-going vessels, has existed from prehistoric times; and a wooden wharf, which was removed less than fifty years ago, is said to have been in existence at the commencement of the seventh century. The quays were extended from time to time, chiefly to the north of the city, and it is related that in 1581 two thousand ships were there at one time, and forty, from Venice, Genoa, Spain, and Portugal, came up on a single tide. Shortly afterwards the navigation of the Schelde was stopped by the Batavian Provinces, and till 1795 the trade of Antwerp became stagnant. The French invasion brought prosperity to the city, by restoring the free navigation of the river, and then the construction of the Jordaens and Van Dyck Quays, and the excavations for what are now known as the Bonaparte and Guillaume Basins were begun. After 1814 the construction of the quays was continued. A bonded warehouse was also built covering 8 acres. It was burnt down in 1901 and rebuilt in reinforced concrete. No additions to the docks were made till 1853, when the Kattendyk Basin was constructed, with a lock giving access to the Schelde, and a large dry dock. These works were finished in 1860, and after the position of Antwerp had been made more secure by the International Treaty of July, 1863, regulating the navigation of the Schelde, the various projects relating to the improvement and extension of the port began to be studied by the Government and municipal engineers and to be criticised by all who took an interest in the subject.

In 1869 the junction dock connecting the Kattendyk to the old docks was completed and the timber dock lengthened; in 1873 the Campine and Asia Docks were opened to navigation; between 1877 and 1880 the Kattendyk Dock was lengthened, and three new dry docks were constructed; and in 1886 the Lefebvre and America Docks were completed. This work was done by the municipality of Antwerp at a cost of over £3,000,000, and during this time the State, to which all navigable rivers in Belgium belong, demolished the old quays and rectified the right bank of the Schelde. New quays, extending about 2¼ miles, cost £1,600,000, and between 1895 and 1902 they were further extended for 1¼ miles to the south, where the municipality had constructed tanks for the storage of petroleum, benzine, turpentine, &c. An area of 75 acres is reserved as a site for these tanks, which are fitted with lightning conductors, safety valves, and all modern improvements. The vessels which bring the oil in bulk come alongside a masonry pier 360 yards long, with berthing for three ships and five pipe lines, each 12in. diameter. Till 1894 the whole of the petroleum which was brought to Antwerp came in barrels and was stored in warehouses adjoining the America Dock.

For nearly twenty years nothing was constructed beyond the Lefebvre and America Basins, the former of which was connected by a lock with the Kattendyk Dock. In 1903 to 1907 Royers Lock was built, giving direct access to the Schelde from the Lefebvre Basin, and in 1903 the new docks to the north of this dock were put in hand. The first of these is a Y-shaped basin, leading from the Lefebvre Basin on the opposite side to the Royers Lock. The lock has an opening of 72ft. and a length of 590ft. The draught of water at ordinary tide is 34ft. 6in. The channel connecting it with the Schelde is 1410ft. long. It is 144ft. wide at the lock and 690ft. between the wing walls, where it enters the river. The right arm of the new Y-shaped dock forms the first basin of the new series; the left, which is called the Canal Dock, has been lengthened and will be still further prolonged; in accordance with the new scheme, as shown on the map below. The area of all the docks made before 1900 was 158 acres, and the Canal Dock and first basin added 63 acres to this. These were finished in 1907. They have a uniform depth of 31ft., and as they communicate with the Schelde through the Royers Lock, which works at all tides, and in ten minutes, the walls of these docks may be considered as if they were river quays, as well as deep-water quays, alongside which steamers with a draught of 30ft. can be moored.

The signing of the Treaty of 1863 brought other subjects under discussion, all of which may be included under the title "Improvements of the Port of Antwerp." It was said that the curves below Antwerp were too sharp to allow vessels longer than those which were then being constructed to come up at any state of the tide, and also that any dock extensions should be made on the left bank opposite the city, instead of to the north of it. The width of the river here varies from 1350ft. to 1650ft., being at its narrowest between the "Tête de Flandres," where there was till recently a large fortress, and the floating pontoon between the North and South Quays. From this point there is a regular service of ferry boats every quarter of an hour, conveying carts and large vans as well as foot passengers to the village of Ste. Anne, which adjoins the fortress on the opposite side.

From the Petroleum Quays at Hoboken to the floating pontoon the river is fairly straight. It then bends sharply to the left, so that a line drawn from the petroleum tanks to Royers Lock would be entirely outside the Antwerp municipal boundary. It may be asked why such a large level tract of land, sparsely inhabited and almost uncultivated, should be allowed to remain unutilised so long, when land at a far greater distance from the centre of Antwerp is being eagerly bought up at continually increasing prices. The answer is because it is in the Province of Flanders.




IMPROVEMENTS OF THE PORT OF ANTWERP

Twenty years ago this subject was mentioned in THE ENGINEER, in describing a project of the late Mr. Greathead, M. Inst. C.E., for a tubular tunnel underneath the Schelde. The Province and City of Antwerp say that they would like to make an "Isle of Dogs" or a "Birkenhead" on the other side of the river and connect it with Antwerp by swing bridges or tunnels; but that, as a vast initial expenditure would be necessary, they want to have entire control of the land. They would then be able to settle on the best means of access and decide whether it would be pre-

ferable to build docks or a good class of dwelling-houses. In either case workmen's cottages would form part of the scheme. But the citizens of Antwerp will not, either as private individuals or as a municipality, support an undertaking where every step must be sanctioned by the engineers of the neighbouring province, and where the new residents would share neither the burdens nor the advantages of Antwerp citizenship. They have therefore asked that the district facing them should form an integral part of their municipality. The Province of Flanders, though it draws practically no revenue from this land, opposed the cession twenty years ago, and still opposes it. For this reason no progress can be made with the various projected tunnels to the south and north of the city, or to the Greathead tube in the centre, whilst the construction of a swing bridge or a "transporter" is even less probable.

Just below Antwerp the river, which had been running in a westerly direction, bends to the north and then to the west, so that from the petroleum tanks downwards an S is formed. The dotted lines marked "Grand Coupure" on the illustration show a proposed deviation, which would have cut out the lower of these bends and have shortened the distance to ports above Antwerp, including Ghent. The project had much to recommend it, but the municipal engineers and others who were consulted thought that the scour caused by the more rapid fall would be dangerous to navigation.

The arrangements actually made are shown on the illustration. The deviation of the river is to be to the left instead of to the right, but all sharp bends will be avoided and the width will be kept uniform. The curve will take away a good deal of land from the left bank, but will not alter the situation as regards the part which is opposite the centre of the city. Lastly, this alteration to the course of the river will not be made until a waterway has been constructed from the old docks to Kruisschans, which is just beyond the lower bend.

When the Canal Dock and First Basin, or "Darse," were finished in 1907 the construction of the second and third Darses was commenced, the Canal Dock being also made a thousand metres—3281ft.—longer. This work will give an additional water area of 195 acres and a little over three miles of quay line, with a depth of water of 33ft. The walls are finished and the erection of sheds, electric mains and standards, bollards, railway lines, and cranes is proceeding, and all will be in working order by the end of this year. A new dry dock is also being made at Quay 61 at the end of the Lefebvre Dock. It has been five years in construction and will be in working order in September. Its length is 722ft. by 108ft. wide, and the depth of the floor below the level of the basin is 31ft. 6in. It is built of brick set in cement with stone edgings at every step. Under the whole structure is a layer of concrete made with cement and "trass." The latter is a volcanic stone, which is brought from Germany. In colour it is a light yellowish brown, and it is softer and less porous than the reddish-brown "puzzolana" found in volcanic countries, such as Mexico, and used there as one of the constituents for concrete blocks. The trass has been found so satisfactory when mixed with cement that it is being used for foundations of road beds for carts and railway lines round the docks. The mixture for these is two parts of ordinary lime to three of trass. The floating door for closing the dock is of steel plates pneumatically riveted. It weighs 550 tons, not including 300 tons ballast. To empty the dock there are three centrifugal pumps, together capable of discharging 65,000 metric tons per hour. The time required to pump the dock dry would be two hours, if there were no ship in it. The total cost of dry dock and accessories was £240,000. There were already six dry docks before these works were begun leading out of the Kattendyk, but none had been built since 1880, and the largest, which is 512ft. by 81ft. and 22ft. 6in. deep, was not big enough for the larger vessels which visit Antwerp. All these docks, even the smallest, which is 148ft. by 36ft., continue in regular use, and the engines, which were built in 1864, are in good order and can pump out 12,000 metric tons per hour.

The Canal Basin is more than a mile long; it will be seen that there is space to lengthen it, if necessary, and to construct another Darse to the north of No. 3. Probably this would have been done if the Grand Coupure had been made. But when this was suppressed and the new position of the river channel agreed to by Government, provincial, and municipal engineers, it was necessary to re-study the whole scheme. The advantages and disadvantages of giving the docks another connection with the Schelde further down the river were again discussed, and finally it was decided to construct a new series of basins, as shown on the map. The cost for the whole project is estimated to be £20,000,000, and the time which is to be taken to complete it fifty years. The work will commence at Canal Dock with a lock facing No. 3 Darse and connecting it with the upper end of the first of the new basins. At the lower end of this basin the main channel turns and runs parallel with the direction of the projected Grand Coupure. From this channel, as will also be seen, there are four arms, and at the end twin locks leading into the river near Kruisschans. In order that there may be a through waterway from Kruisschans to the existing docks with as little delay as possible, it has been decided that at present only one lock shall be constructed, and that the channel which leads from it to the existing work shall provisionally be only 262ft. wide, instead of its full width of 984ft. The contract for the construction of the lock has been let for £552,000, and the work will take four years. It is to be 886ft. long by 115ft. wide, with a depth of 33ft. The channel from the river will be 328ft. wide at the lock and 954ft. at the entrance. In making the channel from the Kruisschans Lock past the ends of the projected new basins, the bottom will be excavated to a width of 262ft. and a depth of 33ft. The wall on the side which is nearer the river will be completely finished, but on the opposite side the earth will be allowed to take its natural slope. Another part of the work which is to be commenced as soon as possible is the extension of the river wall. The quays of Antwerp extend in an uninterrupted line from the Petroleum Pier to Royers Lock, and it is now intended to prolong them for another 1½ miles in front of Austruweel. But the commencement of this work must depend on the rectification of the river channel, so that, although it is very much needed, it will not be possible to start it at once.

The Antwerp Harbour and port works are well provided with steam, hydraulic, and electric machinery for lighting and for the various operations connected with the movement of vessels and their cargoes. The pumps for emptying the dry docks have already been mentioned, but nearly all the other work is done by hydraulic pressure or by electricity. There is a tunnel about 4ft. 6in. high under all the recently constructed quays, and the new quays round the different basins, and in this the electric cables will be taken. All electricity is supplied by the Compagnie Electrique Anversoise at 6500 volts alternating, and it is converted to continuous current at 550 volts in a sub-station at the end of Darse No. 1. There are eighty 2-ton electric cranes and 320 hydraulic, which are partly 1½ tons and partly 2 tons. All the electric cranes have three motors, one for lifting, one for slewing, and one for travelling. They travel on rails, in some cases 13ft. and in others 16ft. 6in. apart, and allow space for locomotives to pass underneath. On the Herbouville Quay (south) where archway cranes were not practicable in consequence of the numerous junctions connecting the railway lines, fifty-one "half-arch" cranes were made. In these one side is supported by a line running along the roof of the sheds. There is also a number of larger cranes in both the old and new docks. On the Ledeganck Quay—which is just below the Herbouville—the town has placed a 50-ton electric crane to obviate the necessity for steamers of regular lines, which have their fixed berths on the river quays, entering the docks whenever they have to load or unload goods weighing more than 2 tons. Two 40-ton cranes, supplied by Sir W. G. Armstrong, Whitworth and Co., of Newcastle, take their power from the Kattendyk hydraulic station, which also till recently worked a 120-ton sheer legs, supplied by the Société Cockerill in 1878, but are now driven by current supplied by the Antwerp Tramway Company at a tension of 550 volts. Besides the 2-ton electric cranes, the Canal Dock has a 30-ton electric crane, with separate motors for lifting, slewing, raising and lowering jib, and travelling. This crane is specially used for unloading marble, &c., at Quay No. 71. There are numerous other electric and hydraulic appliances. The swing bridges are worked hydraulically, the pressure being 700 lb. per sq. in. There are electric traversers for railway trucks on the river quays, and electric capstans round the new docks. Besides the principal sub-station where electric current is received from the Antwerp Electricity Company, there are eight subsidiary stations, in which the current is lowered to 235 volts for the crane service, and in four of them there are also transformers for the lighting current, which is triphase at 225–230 volts. Only incandescent lamps with a candle-power varying between 50 and 1000 will be used. For the new basins, which are to be brought into use this year, a fixed 50-ton electric crane and twenty-four travelling cranes of 2½ or 3 tons will be required. Besides these, thirty 2½-ton electric cranes are being made at Charleroi and six 5-ton cranes at Liège.

Amongst the special appliances used at these docks the floating grain elevators take a leading place. Of these there are eight in use, and four more are being constructed. The grain is brought in sacks, but these are opened on deck and the contents pass down a shoot into a lighter. A group of four tubes is lowered into the lighter and the grain is raised by suction and is delivered through a single tube at a speed of 200 tons per hour for each elevator. A grain warehouse has been built, which has an area of 2800 square yards, and, like the power-houses and all other dock buildings, even the workmen's shelters, it is artistically designed. On the South Quay of the Campine Dock there is a coal tip, which has been in service since 1898. It is used for shipping coal and is worked by hydraulic pressure. The trucks are run on to a platform which is raised by means of a plunger and a block and tackle till it is high enough to reach a sliding shoot, the position of which may be varied as desired. The pressure is then made to act on only one part of the plungers, the truck is tilted and then stopped automatically by two bolts, locking into its fore axle, when the door is opened by hand, and the contents tipped into the hatchway. Like many of the other appliances, it was made by Armstrong, Whitworth and Co., For ore transhipment there is a barge carrying two movable cranes, which can work simultaneously on the same hatchway. It is placed between the sea-going vessel and the lighter to be loaded and can manipulate and weigh 80 tons per hour, or 800 tons per working day. The cost was £6000. The total tonnage of Antwerp port for last year was 14 millions, of which three-quarters was English, besides six million tons of internal traffic.

Till 1875 there were no steam tugs belonging to the port, but in that year the city bought three, of which two were sold and one is still in use. In 1881 new boats were bought, and one of these had the peculiarity that it was fitted with a steam pump able to supply 800 gallons of water at a pressure of 85 lb. per min. This was found very useful, not only in case of fire, but for pumping dry or keeping afloat any vessel with a dangerous leak. As these gave such excellent results the city decided that all their tugs should in future be fitted with identical pumps, and one has also been supplied to the boat used for collecting navigation dues. The first twelve tugs had engines of 100 nominal horse-power, but those now being built will develop 130. There are also several petrol launches for harbour service.

The extension of the Antwerp quays to the south, the construction of the petroleum tanks and pier, and the large workshops of the Société Cockerill and other firms at Hoboken, are all arguments in favour of tunnels, but against swing bridges, "transporteurs," or other structures which would interfere with the navigation. But whatever may be the future of the land behind the Tête de Flandres, the fact remains that many of the inhabitants of the villages within ten miles of Ste. Anne earn their daily bread in Antwerp, chiefly by the supply of dairy and farm produce. For many years the existing ferry boat service has been inadequate, especially for heavy wagons, and it is only the advocates of a speedier and more convenient method of transit who have prevented its improvement. On the Antwerp side, between the north and south quays, is a floating stage. The masonry walls at the ends and at the side towards the quay were commenced in 1877 and finished in 1884. It is also partly enclosed on the river side by a masonry wall, and there is a hinged gangway parallel with the quay wall. About three years ago a lift was constructed at the other end, with a platform large enough to accommodate a pair-horse van, so that at low water a vehicle can be raised to the quay level in a few seconds. On the Ste. Anne side there is a long, yet steep, sloping path, and the ferry boat is moored to that part of it which is just uncovered by the water. Foot passengers must wait till the carts have drawn off before they can land.

These inconveniences will be remedied and the transit accelerated by a landing stage which is now being built just below the village. The Prince's Landing Stage at Liverpool was taken as a type, though there are several modifications. The pontoon is 328ft. long by 65ft. 8in. wide, and the bridge or gangway, which is at right angles to the river, has a length of 482ft. It has a masonry wall on either side, the distance between these being 40ft. and the width of the bridge 34ft. 6in. The bridge is not rigid, but is supported by five groups of eight small pontoons. Joists run from one row of pontoons to the next and are connected by cover plates, the last lengths, where they join the landing stage, being on rollers. On the main joists are cross joists, which carry the deck. There is a tunnel in one of the masonry walls with three openings on the inner side. By this means if any of the small pontoons or other part of the substructure requires to be removed, it can be taken out without disturbing the deck. From the face of the masonry to the pontoon there are girders 125ft. long. They taper from the middle towards the swivel ends, being curved top and bottom. They are connected by cross chains, with links 12in. long and 2in. diameter.

The woodwork of the gangway is entirely of oak, but the pontoon is decked with deal. There are 980 tons of steel in the structure, 15,000 cubic feet of oak, and 2500 cubic feet of deal. At each end of the pontoon there are two independent groups of pitch-pine guide piles, one outside the other. The piles are 16in. square with 12in. by 12in. bracing and 12in. by 6in. walings, making together 22,000 cubic feet of pitch-pine. The width of the river at this point is 1480ft., and as the set of the current is towards the Antwerp side, the pontoon will not interfere with the navigation. It is expected that the whole work will be ready by the end of June. As at present, there will be a service every quarter of an hour, but it will only be for foot passengers. A separate boat for vehicles will run once an hour.

The dry dock and new basins were designed by, and are being constructed under, the superintendence of M. Fr. de Winter, Chief Municipal Engineer. The hydraulic and electric works with all accessories are by M. A. Le Paige, Chief Engineer of the Mechanical Department, and all work connected with the landing stage at Ste. Anne is being carried out by M. J. Mélotte, Ingénieur des Ponts et Chaussées. These gentlemen have all kindly assisted in supplying the information from which the foregoing article has been prepared.

## POWER FROM MERCURY VAPOUR.

In a paper read some little time ago before the American Institute of Electrical Engineers Mr. W. L. R. Emmet describes a thermodynamic process using a mercury boiler in tandem with a steam generating apparatus for the production of power. It does not seem to us that the author's idea is likely to prove very valuable, but his paper is nevertheless interesting and worthy of some attention.

The theoretical limit of efficiency in a thermodynamic process, it is pointed out, is the ratio of the temperature range embraced by the process to the maximum absolute temperature used, and is expressed by $\frac{T - T_1}{T}$ where T is the initial temperature and $T_1$ the final temperature. In all processes available for commercial power

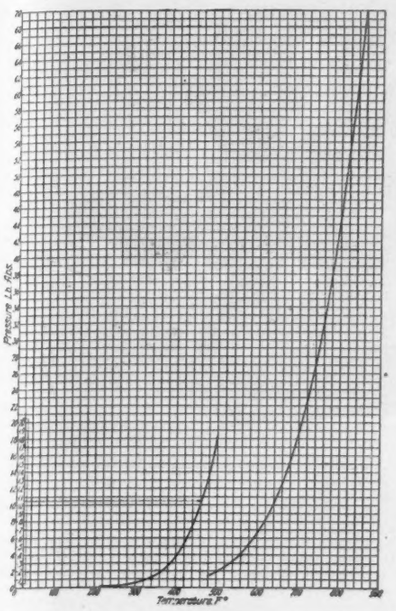



Fig. 1—BOILING POINTS OF MERCURY AT DIFFERENT PRESSURES

development the lower limit is fixed by the temperature of cooling water available, and is therefore not susceptible of variation. The possible upper limit is the temperature which can be produced by burning fuel with air, and in practice is about 2700 deg. Fah. With the object of utilising some of the energy available in ranges above those possible with steam, Mr. Emmet has directed his attention to the question of using mercury vapour. The theoretical efficiency of steam processes can be increased by using higher pressures, but since with rise of temperature the increase of pressure is very rapid, and since the steam turbine has limitations in the efficient use of high pressure improvement in this direction does not appear very promising. At atmospheric pressure mercury boils at 677 deg.

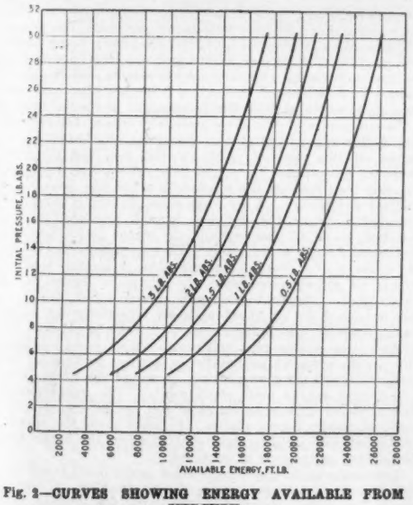



Fig. 2—CURVES SHOWING ENERGY AVAILABLE FROM MERCURY

Fah. and condenses in a 28in. vacuum at 455 deg. Fah. So far as temperature and pressure are concerned, therefore, it is well adapted for a temperature cycle having a range in excess of that permissible with steam. It is therefore proposed in the paper under consideration to use mercury in place of water. The principle involved was suggested to the author by Mr. Charles S. Bradley, who proposed and patented a similar process. There have been other proposals along the same lines, but none have involved the use of mercury.

The author has constructed apparatus of about 100 horse-power, and experiments with the new process are being carried out. In studying the thermodynamic possibilities of a substance such as mercury, the same considerations are taken into account as when dealing with steam. The author sets down the leading data in the following manner:—Boiling point of mercury at atmospheric pressure, 677 deg. Fah. (358 deg. Cent.); boiling point of mercury at 28in. vacuum, 457 deg. Fah. (236 deg. Cent.). Vapour density is in the ratio of atomic weight and absolute temperature; that of mercury is 6.56 times greater than that of water at boiling point and 6.8 times greater at a vacuum of 28in. The specific heat of liquid mercury is .0373, and that of mercury gas at constant pressure .0248. The latent heats of vaporisation at 25 lb., 15 lb., 28in. and 29in. vacuum, are 117, 118, 121, and 121.5 British thermal units respectively. The boiling point of mercury at various pressures is shown by the curve, Fig. 1, and curves are also given in Fig. 2 showing the theoretical energy available from mercury

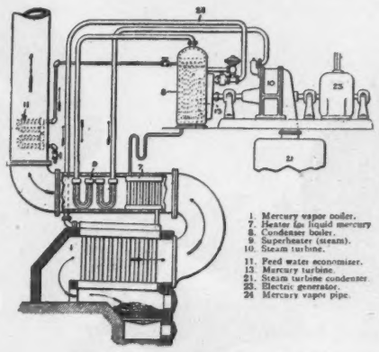



Fig. 3—ARRANGEMENT OF PLANT

within various pressure ranges. These curves are calculated from Rankine's formula.

Briefly, the process may be described as follows:—Mercury is vaporised in a boiler heated by a furnace of the ordinary type. From this boiler—see Fig. 3—it passes at a pressure not much above that of the atmosphere to the nozzles of a turbine, which drives a generator or any other machine. From this turbine it passes to a condensing boiler, where it is condensed on the outer surface of tubes which contain water, and this water is vaporised by the heat delivered and the steam produced used to drive other turbines or for any other purpose. Preferably this condensing boiler is placed at a level above the mercury boiler, so that the condensed liquid runs back into the mercury boiler without the aid of a pump. Since the mercury vapour is much hotter than the steam, the gases under normal conditions leave the boiler at higher temperatures than they have in leaving the steam boiler. To utilise this excess heat in the gases, it is proposed to convey them, first, after leaving the mercury boiler, through a heater, which raises the temperature of the returning liquid almost to the boiling point. They are then passed through a superheater, which superheats the steam delivered by the condensing boiler, and finally through an economiser, which heats the feed water for the condensing boiler and so reduces the gases to the lowest flue temperature practicable. The disadvantages attending the use of mercury are as follows:—(1) It is very expensive. (2) It is poisonous, and capable of pervading the atmosphere in a finely divided state. (3) There are difficulties in confining the

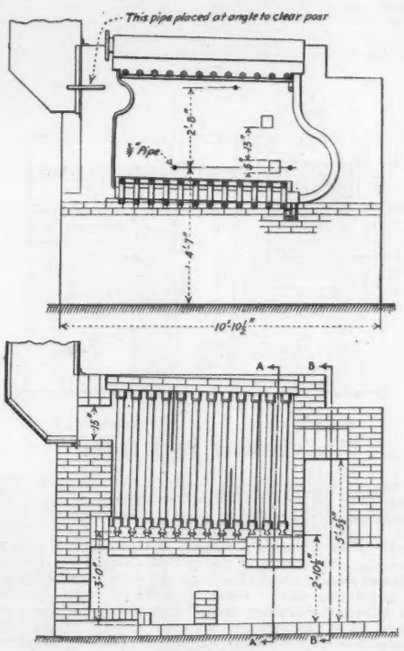



Fig. 4—ARRANGEMENT OF BOILER

vapour and liquid. On the other hand, the temperature of mercury at boiling point is a very convenient temperature; its specific gravity makes possible the use of gravity feed, and at the temperatures adopted with this new process it is completely neutral, and has no detrimental effect upon the substances it comes in contact with. It carries nothing in solution that can adhere to heating surfaces, and the boiler therefore is always perfectly clean. Its vapour density is so high that the spouting velocity is very low, and a very simple type of turbine can be used, and as it does not wet the surfaces of the turbine blades there is no erosion. It is believed that the efficiency of the turbine will be high, but no data is yet available to support this assumption. The volume of the vapour at convenient condensing temperatures is such that the heights of the blades need not be excessive. Owing to the manner in which the heat is delivered to the condensing boiler, the latter is very small and simple. Steam boilers, it is pointed out, transmit on an average about 6 watts per square inch, with an average temperature difference of about 1100 deg. Fah., whereas a surface condenser transmits 18 watts with a temperature difference of 20 deg. Fah. The dimensions of a mercury boiler are equivalent to those of a surface condenser, and since there are no high temperatures, there is no possibility of scaling or burning. Moreover, the boiler is always clean.

The mercury vapour acts automatically as a conveyor of heat from the fire to the condensing steam boiler. If through loss of load or other causes the supply to the mercury turbine is shut off, the vapour by-passes through a safety valve, so that all the heat delivered to the mercury

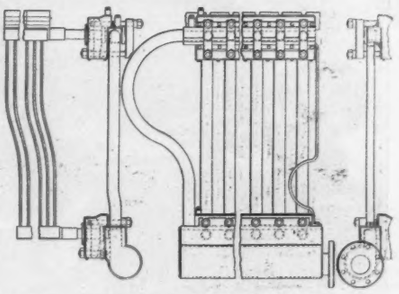


Fig. 5—TUBES AND HEADERS

is immediately conveyed to the steam boiler. Assuming the heat deliveries to exposed surfaces to be equal to those in steam boilers under equivalent conditions of temperature difference, gas velocity and radiation, and assuming a turbine efficiency equal to that of steam under equivalent velocity conditions, calculation shows that in an efficient power station the same amount of steam can be delivered to the turbines at the same superheat, thus giving the same turbine output, and that, in addition, about 66 per cent. of the power so delivered can be delivered by mercury turbines, the fuel required being only about 15 per cent. greater than that which would be used with a steam plant alone. Thus the gain in capacity in an existing station would be approximately 66 per cent., and the gain of output per pound of fuel 44 per cent. This calculation is based upon a mercury vapour pressure of 10 lb. above the atmosphere and a vacuum of 28.5in. at the steam turbine outlet. It is estimated that about 10 lb. of mercury would be evaporated for each pound of steam produced, the steam gauge pressure being about 175 lb. and the superheat 150 deg. Fah. The final temperature of the gas after leaving the economiser would be about 300 deg.

The vacuum in the steam and mercury turbines could be maintained by the same air pumps, means being provided to separate all mercury from the air in a cooler. Tests have indicated that not more than £2 worth of mercury would be required per kilowatt output of the mercury turbine, and it is considered that with suitable arrangements this amount can be considerably reduced. The general application of the process would naturally involve a large demand for mercury, but, according to Mr. Emmet, this would not permanently increase the price. At the time the paper was read the experiments that had been made consisted of producing the vapour in heating elements similar to those proposed for a boiler working under the most severe conditions of heat delivery by gas flow and radiation. The vapour was carried from these elements to a nozzle and exhausted

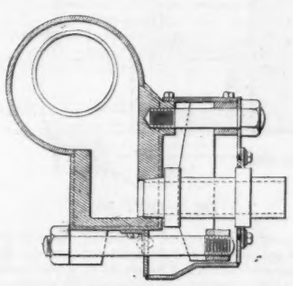


Fig. 6—JOINT BOX

into a condenser, from which the liquid was drained back into the boiler by gravity, the vacuum being maintained in the condenser by an air pump. The only element lacking in this experiment was the turbine. Mr. Emmet points out that this is really of little importance, since the nozzle is the real engine which transforms heat into motion, the movement of the wheel by the moving fluid being a mechanical matter governed by laws well understood. In these experiments pressures and quantities of liquid condensed were measured, and these measurements were in agreement with the calculated values.

Having obtained by experiment data concerning possible rates of heat transference, a boiler was built in which the heating surface was made up of round tubes with concentric cores. These tubes were expanded into a horizontal metal sheet, which formed the bottom of a box, and arrangements were made by which the central ducts in the cores always received a supply of liquid. Certain difficulties arose, however, which led Mr. Emmet to abandon this design and to adopt the principle shown in Fig. 4

# MANCHESTER MINING EXHIBITION—STEAM TURBO PUMP

MATHER AND PLATT, LIMITED, MANCHESTER, ENGINEERS.

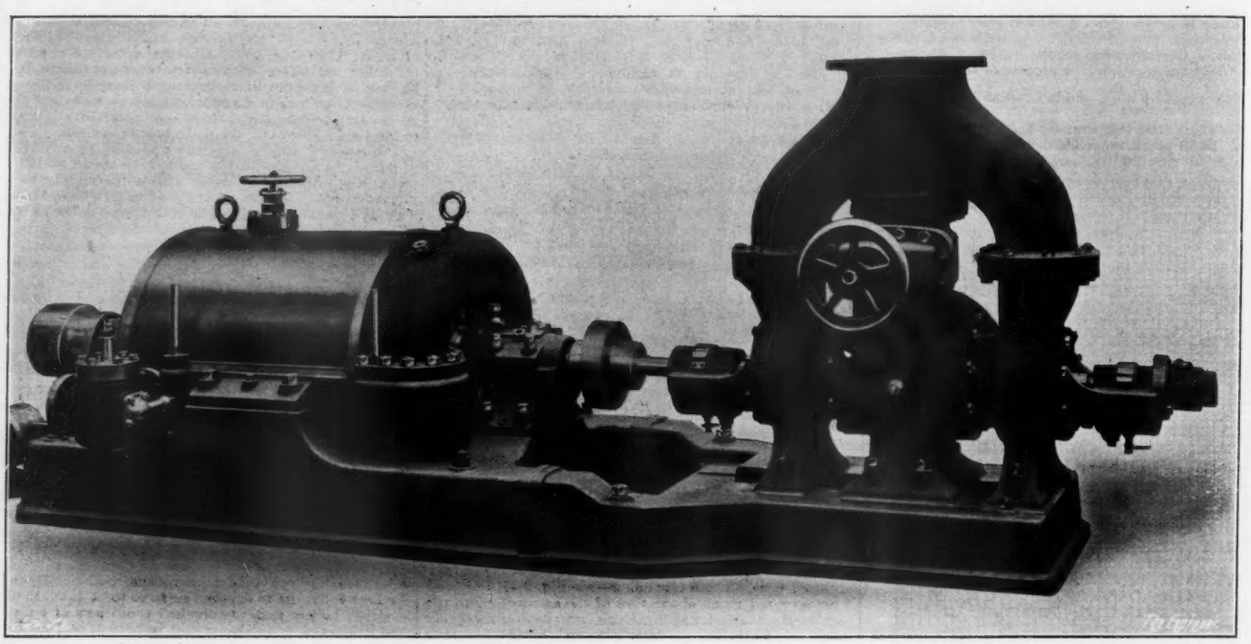


Fig. 1

Each heating unit consists of an upper and lower header, which are connected together by flattened tubes, curved in the manner shown in Fig. 5. These flattened tubes are connected to the headers by acetylene welded joints. The tubes are first welded from the inside into channel-shaped pieces, and these channels, with the set of tubes connecting them, are then annealed so as to release all strains incident to welding. After they have been annealed they are tested with high-pressure air, clamps being used to confine the air in the channels. The channel pieces are then welded to steel headers, so that the whole unit becomes perfectly tight and capable of standing a high pressure. The headers of these units terminate as shown in taper nozzles which fit into taper holes in the bus header at the bottom, and into a vapour chest at the top. A curved duct connects the vapour chest to the bottom header at the hot end, so that the heating units which are exposed to the greatest heat receive the most direct supply of liquid. Moreover, in these units a larger internal space is allowed than in the units which occupy the cold part of the boiler, so that the colder part does not carry an unnecessary amount of liquid.

To guard against loss through leakage at joints the arrangements shown in Figs. 6 and 7 are used, by means of which the sets of joints at the top and bottom of the boiler are enclosed in boxes practically air-tight, the bolts used

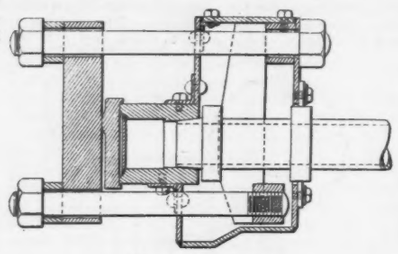


Fig. 7—JOINT BOX

for tightening these joints extending outside the boxes in such a manner that a leaky joint can be drawn up. These boxes are connected by ducts to a condensing cooler in which a low pressure is maintained by suction from the base of the chimney stack or from any other sufficiently exhausted place. This suction will maintain within the boxes a pressure lower than any other pressure that surround them, so that there is a constant inflow of air through all leaks and a flow of all liquid or vapour which may escape, into the cooler where it is carried through passages over water pipes until all the vapour is condensed and nothing but cool air and gas is discharged. In a similar manner any joints in the system which are liable to leak can be enclosed in boxes and connected to the same cooler, and by this means all possible waste, except, of course, that which may occur in the heating units, can be eliminated In case there should be loss of mercury in any of the heating units means are provided by which such loss can quickly be discovered before a large amount of mercury escapes. The feed of each boiler is governed automatically by the difference of pressure between the lower header from which liquid circulates and the pressure in the vapour chest, this being the pressure necessary to produce sufficient circulation. At the back of the valve which admits the feed water is a reserve chamber, and connections are provided by which the level of liquid in this reserve chamber is visible to the fireman. In the event of loss of liquid being noticed, the doors would be opened, the fire drawn, and the liquid drained out of the boiler into a receiving tank. The boiler might then be tested with air pressure and the leaky elements repaired.

The first turbine used was an old experimental steam turbine which had many joints that were difficult to keep vacuum-tight, but the new turbine has but one joint, and it is constructed so as not to leak. Drawings of the boiler setting are given in Fig. 8. The new condensing boiler is made from a standard high-pressure feed-water heater having a water space at the top and bottom and connected together by tubes in the ordinary manner. This boiler has apparently worked satisfactorily, and has produced steam from mercury vapour in the manner expected, but it is not considered a suitable design for the purpose, since the temperature differences impose a strain on the expanded tube sheets. It is considered that tubes attached at one end with concentric circulation after the manner of the Niclausse boiler will be the most satisfactory construction for such condensers.

The plan that has been considered for commercially applying this process is to produce a simple type of unit that can be accommodated on the same floor space as a

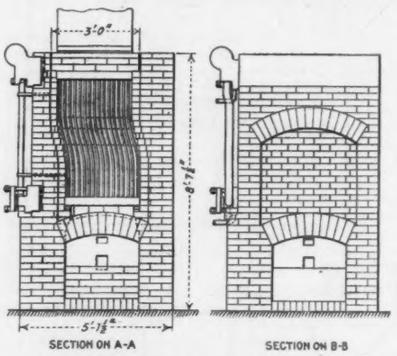



Fig. 8—MERCURY BOILER SETTING

standard 500 horse-power steam boiler occupies. The unit would be designed so that the steam output of the condensing boiler would be equal to that obtainable from the standard 500 horse-power boiler. For each of these boiler units a separate turbine and generator would be provided, the nature of the process being such that the efficiency is not affected seriously by such a multiplication of generating units. Since it would never be desirable to operate the mercury-driven units alone, the generators could be of the synchronous or asynchronous type and completely enclosed, clean air being supplied to them from outside the building.

The author says that without the acetylene welding process the design of a satisfactory mercury boiler would have been very difficult. The possible cost of the commercial application of such a process has not yet been carefully studied, but the author considers that if existing stations were equipped with plant designed in accordance with his ideas the cost per kilowatt of added power would not exceed the present cost per kilowatt of well-designed steam stations, not including the cost of real estate. The process, provided it proved successful, would, it is contended, greatly extend the capacity of existing stations and postpone the building of new stations. The saving would about cover the real estate values, and the gain in fuel economy over that of the best existing plants should be about 45 per cent. With the most efficient oil-fired boilers the process ought to give, in Mr. Emmet's estimation, a fuel economy very near to that obtainable with Diesel engines.

## MINING EXHIBITION IN MANCHESTER.

No. II.*

THE excellent display of turbine pumps made by the firm of Mather and Platt, Limited, forms a very conspicuous feature of the exhibition. The axial flow pump operated by a Zoelly steam turbine is specially designed to meet the demand for a pump to deal with large quantities of liquid against a low head and at the high speeds of rotation which accompany the direct drive of electromotors or steam turbines. The chief advantages of such a plant as that shown in Figs. 1 and 2 over the ordinary slow-speed centrifugal plant are saving in space, foundations, and first cost. The pump shown is capable of delivering 3600 gallons per minute against a total head of 60ft. when running at 3000 revolutions per minute. The pump is of the two-chamber variety, the chambers being fitted with impellers of special design and working in parallel. The water enters by a central suction branch and chamber, whence it is delivered through a breeches pipe into the common delivery main. Guide passages of special design at the entrance and exit of the impellers ensure the correct flow of the water through the channels. A characteristic feature of this type of pump is that the load becomes larger as the output for which it is designed is reduced, and this load reaches the maximum when the delivery is stopped altogether. A by-pass arrangement is therefore provided between the delivery branch and the suction chamber, so as to short-circuit the water as its delivery through the main is restricted. This arrangement enables the plant to be started up with the minimum load, a feature of importance when the pump is driven by a squirrel-cage alternating-current motor. The pump is also arranged to be fitted with an air-extracting pump driven by gear wheels from the main shaft to exhaust the air from the suction pipe and pump casing when starting. This small pump is automatic in action, so that in the event of the main pump losing its water the little pump comes into action and reprimes it. The combination shown would appear to be ideal for use as a circulating pump in steam power plants. In such cases the spindle of the turbine could be extended to drive the boiler feed and rotary air pumps as required.

A second exhibit made by Mather and Platt's is the 6in. belt-driven centrifugal pump shown in Figs. 3 and 4, which has been designed particularly for dealing with semi-viscous liquids such as sewage sludge. The outstanding features of its construction are the hinged cover on the suction slide to allow of easy inspection of the inside of the pump without disturbing either of the branches, and the open type impeller which can be readily cleaned. It will be noted that the hinged cover is provided with a renewable phosphor bronze plate, which can be replaced in case of wear. This type of pump, we are informed, is largely used for dealing with paper pulp and bleach works' effluents.

A third exhibit by Mather and Platt is shown diagrammatically in Fig. 5. It consists of a turbine boiler feed pump coupled to a direct-current motor. The principal feature of the pump is the possibility of arranging three separate circuits for the water delivery. One circuit is taken from

* No. I. appeared June 19th.

the suction side through the valve A, part of the turbine pump B, valve C, through the economisers D, valve E, to the low-pressure boilers. Part of the delivery from the same circuit is taken through the valve F into the remaining portion of the pump and through the valves H and J and delivered into the high-pressure boilers. Should it, however, be necessary to shut the economisers down, or should a breakage occur in the pipe line from the pump to the economisers, it is possible by closing the valves C and F and opening the valves G to pump from the suction through the valves A, B, G, H, and J direct into the high-pressure boilers. A feature of this arrangement is that any of the valve connections might be closed or opened at any time, thus changing the circuits without stopping the plant. The motor is of the latest design and is fitted with a sliding cover at the commutator end so as to enable the brush gear to be inspected when necessary.

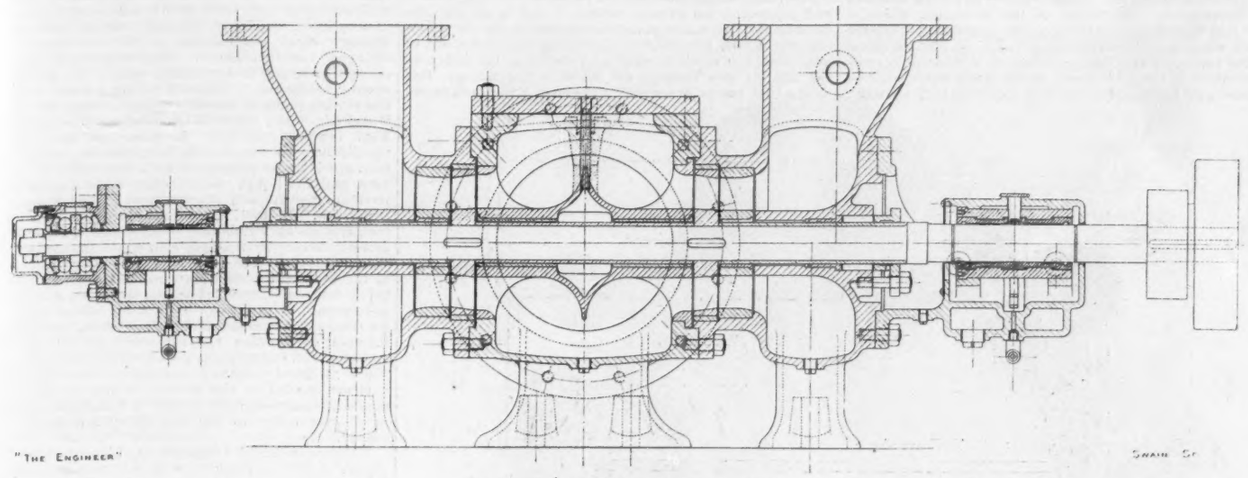



Fig. 2—AXIAL FLOW CENTRIFUGAL PUMP

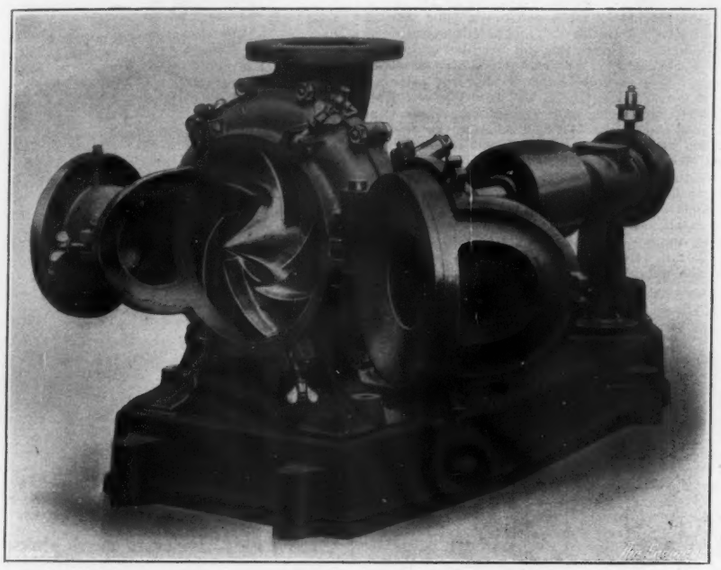


Fig. 3—CENTRIFUGAL PUMP FOR DEALING WITH SEMI-VISCOUS FLUIDS

Of particular interest to colliery proprietors and managers are the two exhibits of Edw. Bennis and Co., Limited, Bolton. One is the self-cleaning compressed air furnace arranged for hand firing, and the other is the new link chain grate stoker. The former consists of a strong cast iron front, lined with fire-brick and fitted with a door of ample size for hand firing. The fire-bars are of the Bennis self-cleaning trough type, each trough being provided with an independent superheated steam jet blower and fitted with grids having graduated air spaces. A shaft carrying cams for each bar is placed beneath the front to operate the bars, compelling them to agitate the bed of fuel and convey it to the back of the grate where the clinker is deposited in a pit. During the process of cleaning out the ashes there is no fall in the steam pressure such as is usual with ordinary hand firing. Fig. 8 shows the new Bennis link chain grate stoker. In this appliance the links are halved together and rounded at their ends, and the drive is arranged to give six variations of speed to suit various classes of coal and varying loads. The grate can also be used with forced draught. The provision of the air seals, the machine-cut six-speed gear running in oil, and the ball thrust bearings are among the latest improvements.

The Herbert Frood Company, Limited, Chapel-en-le-Frith, has an interesting exhibit, including the latest developments connected with the material known as "Ferodo," which is now so extensively adopted for the lining of brakes and clutches. It is a material with a very high coefficient of friction. We were particularly interested in the new method of dissipating the heat generated by the action of brakes lined with this material. This embraces the employment of a lining of corrugated metal interposed between the material and the drum to which it is secured.

Steam users will find several stands with exhibits which ought to provide food for thought. Amongst these are the Lea Recorder Company's stand, which is arranged generally to illustrate the continuous measurement of flowing liquids over V notches and weirs by means of this firm's instruments. J. Hopkinson and Co., Limited, Huddersfield, have an exhibit comprising two full-size models of two-flued and water-tube boilers equipped with their boiler mountings. A feature of this firm's valves is the use for the valve seats of "Platnam" metal, which is harder than bronze and non-corrodible. We are informed in the catalogue that this metal has been working satisfactorily under superheat at 750 deg. Fah. for some time. Lancaster and Tonge, Limited, Manchester, show steam traps, dryers, pistons, metallic packings, and Lancaster piston rings ranging in size from 12in. to 6ft. Sir W. H. Bailey and Co., Limited, Manchester, in addition to exhibits of Köster air compressors, Davidson feed pumps, and the "Aqua-thruster" pump—all of which are familiar to our readers—show a new fan engine recorder for mines. This instrument has been designed to meet the requirements of the new Mines Act, and gives a permanent and easily legible record of the air pressure produced by colliery fans. Messrs. A. Bolton and Co., Manchester, show their steam superheaters with Field tubes and no looped ends for all kinds of generators. The new sectional type makes provision for the rapid removal and renewal of the tubes without employing studs or set screws. Mr. John Thompson, Wolverhampton, shows a small boiler of the dish-end pattern and a section of a large boiler of this pattern, 9ft. 2½in. diameter, to demonstrate how the usual stays can be dispensed with. In connection with the dish-ended boiler the latest practice is to fit in the flues a corrugated section about one-quarter of their length to give increased heating surface and take up expansion and contraction strains. This firm also shows sections of both horizontal and vertical water-tube boilers. The Kennicott Water Softener Company is represented by a water softening plant with the most recent improvements. The Leskole Company, Limited, Enfield, shows numerous instruments, such as water-gauge recorders for mine ventilation work, volume meters for coke oven, blast furnace, and producer gas, water and steam meters and $CO_2$ testers. The steam meter shown by this firm depends for its action on the drop in pressure caused by a disc inserted between two flanges of the steam pipe and having a bore slightly less than the internal diameter of the pipe. The slight loss of pressure caused by throttling the steam is measured on a special form of differential pressure gauge, the values being directly converted into pounds of steam by the use of Zeuner's formula. Such a system is, of course, not new, but this firm claims that all the objectionable features met with in some forms have been eliminated, as regards the differential indicator itself and its connections, and by applying electrical resistance instruments for the production of continuous records. It is claimed that this system allows of very short pipe connections between the disc and differential gauge, and yet furnishes a record of the weight of steam any distance from the point where the disc is inserted. Nor is the mercury column in the gauge called upon to perform any mechanical task which involves the use of stuffing-boxes or packed glands. The Mechanical Hammer Company, Limited, Stalybridge, is showing in operation various types of hammers for smiths' work, which should prove great economisers of labour in this department. The multiple-headed hammers are operated by power and are provided with means for

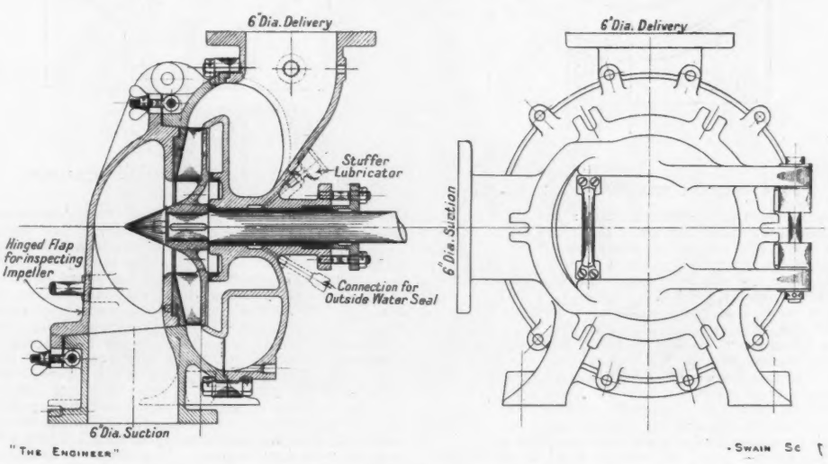



Fig. 4—PUMP FOR DEALING WITH SEMI-VISCOUS FLUIDS

the adjustment of the dies and regulation of the force of the blows.

A signal indicator or register, to work in conjunction with a wire running from the pit bottom of a colliery to the engine-house at the top, is exhibited by Mr. John Milburn, of Workington. The object of the invention, which is shown in Figs. 6 and 7, is to give the engineman in charge of the winding a visible record as well as an audible signal of the nature of the message that it is desired to communicate from the pit or shaft, which visible record remains in view until the signal for another operation is given, when the first signal is automatically cancelled in registering the second.

The apparatus is provided with a dial of sufficiently large diameter to allow of figures or letters being clearly displayed, and there is an index pointer operated by a pawl and ratchet wheel, a detent being used to prevent the ratchet wheel and index from running back through the recoil of a spring. The figures on the dial, of course, correspond to the number of raps or rings on the gong by which the requirements of the men at the bottom of shaft are made known. The spindle of the index carries the ratchet wheel A, which is under the influence of a coiled spring, so that normally the index is returned when released to the zero position against a suitable stop. Adjacent to the ratchet wheel behind the dial is the operating rod B, which carries a pawl C for turning the ratchet wheel, so that one pull from the pit would advance the pointer from the zero position to numeral 1 on the dial, the second pull to numeral 2, and so forth.

The operating rod is weighted, while the operating wire is attached to the upper end of the rod, and, passing round a pulley, descends into the pit. When the wire is drawn down the operating rod is pulled up, the pawl slipping past the teeth of the ratchet wheel; but when the wire is liberated the rod falls under the action of gravity and the pawl moves the ratchet wheel forward one tooth, thus turning the index to numeral 1 on the dial, and so on. Meanwhile the ratchet wheel is prevented from turning back through the recoil of the spring by a detent lever D below the ratchet wheel, with which it is held in engagement by a spring E. This detent lever is only thrown out of gear by an arrangement to be presently described, though provision may be made to enable the detent to be operated by hand to release the ratchet wheel if required. Whenever the pawl actuates the ratchet wheel a tooth, a catch pin L on the rod B operates the hammer M of a gong N, and gives one rap, and the index registers the number of rings or the number of pulls that have been given to the wire. Pivoted below the ratchet wheel A, and adjacent to the detent lever D, is a rocking lever F, which is weighted at one end, and which is provided with an upstanding arm or cam member G, the end of which lies in the path of a roller or abutment H on the operating rod B. The rocking lever F, on the side of its pivot away from the weight, is connected by a rod to the piston of a cataract or dashpot J, and is also provided with a weighted pawl or tumbler K adapted to slip into or engage with a catch or ledge on the detent lever D. On an upstroke of the operating rod—*i.e.*, whenever the wire is pulled once from the pit—the roller or abutment H moves the cam member G over, thus lifting the weighted end of the rocking lever F and depressing the cataract piston J, and hence also the tumbler K. This action of depressing the tumbler depresses also the detent lever D, thus throwing the detent out of gear with the ratchet wheel and enabling the index to fly back to zero through the recoil of the spring. But by the time the weighted end of the lever F has been raised to its full height the tumbler K has slipped off the catch on the detent lever, thus throwing the detent again into gear with the ratchet wheel by the action of the spring E. When the wire is liberated the pawl C on the actuating rod B operates the ratchet wheel A one tooth, thus moving the index to numeral 1 on the dial, and simultaneously the gong is sounded once. Meantime the weighted end of the rocking lever overcoming the cataract, slowly descends to its original position, the pawl G slipping, after an interval, again into the catch on the detent lever. This completes the operation, and the index remains at numeral 1 until the wire is again pulled from the pit.

If the wire from the pit is pulled and released, say, three times in quick succession, the mechanism operates three times—that is to say, (*a*) the detent lever is moved out of gear with the ratchet wheel so that, first of all, the index flies back to zero; (*b*) the gong is rapped three times; and (*c*) the ratchet wheel is operated three times to move the index to numeral 3 on the dial. As the three pulls and three liberations of the wire are made in fairly quick succession, the weight at the end of the rocking lever F has not time between the rings to overcome the cataract or dashpot so as to bring the tumbler K again into engagement with the notch on the detent lever, so that the ratchet wheel is not released at the second or third pulls, though the index finger is carried round from 1 to 2, and from 2 to 3 on the dial, and will remain in this position until another signal is given. The mechanism also allows of signals 4, 5, 6, and 7, or any other desired number being given, each numeral being indicative of some special requirement, such as "draw up coal," "draw up men," "lower cage," &c. Thus it will be seen that the apparatus indicates on a dial the number of times the gong has been sounded in giving a particular signal, and if the pulls on the wire are made in quick succession the index finger is not returned to zero, this return not being brought about until the next signal is given. The dashpot or cataract is, of course, an important feature, because it is by reason of it that the return of the pointer to zero between each of a fairly quick succession of rings is prevented. The pawl on the actuating rod only actuates the ratchet wheel on the down stroke, while on the up stroke the pawl is returned to its original position by a projection on it coming into contact with a stop and being held there by a spring.

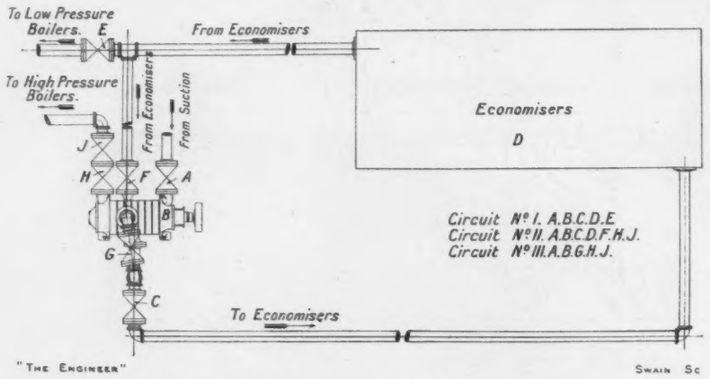



Fig. 5—ARRANGEMENT OF TURBINE BOILER FEED PUMP

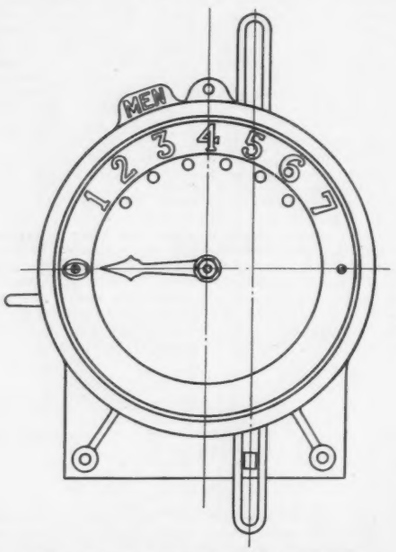



Fig. 6—COLLIERY SHAFT SIGNAL INDICATOR

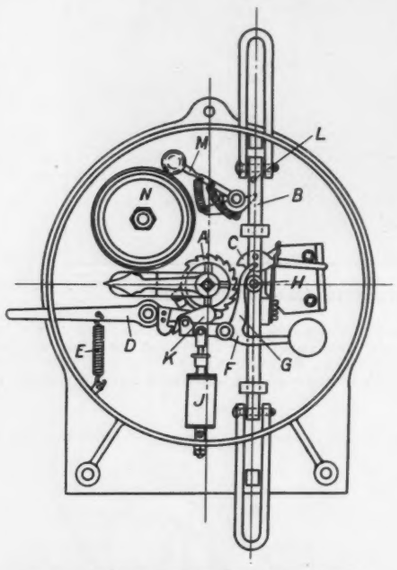



Fig. 7—COLLIERY SHAFT SIGNAL INDICATOR

Engineering Supplies, Limited, Victoria-street, London, have a comprehensive exhibit of thermometers, pyrometers, steam meters and governors. The Steinle steel mercury thermometers have been on the market for some time and their action depends on the expansion of mercury enclosed under high pressure in a steel system, comprising a container, capillary distance tubing and capillary spring. When the mercury in the container expands owing to an increase of temperature, this expansion causes the spring to uncoil and operate the dial hand or writing mechanism. As most of our readers are aware, the boiling point of mercury under atmospheric pressure is 680 deg. Fah., but at a temperature of about 500 deg. Fah. ordinary mercury thermometers are somewhat unreliable. In the Steinle thermometer, however, the mercury is under pressure, which rises with the temperature, and the liquid can therefore be heated far beyond its boiling point and yet continue to follow the law of expansion. In fact, we are informed that the limit of temperature at which this thermometer will work satisfactorily is only fixed by the heat which the steel container will withstand. The governors shown on this stand are of the well-known Hartung type, adapted to all kinds of prime movers. There are spring governors and weighted governors for expansion or cut-off valve gears, load governors for pumps and compressors, governors for internal combustion engines, servo-motors and water turbines. In the spring governor of the sleeve type when the centrifugal masses commence to rise they actuate a sleeve guided in the axial direction of the governor spindle, whence the adjustment is transmitted by means of a lever collar to the controlling mechanism of the engine.

Bleichert's Aerial Transporters, Limited, New Broad-street, London, show a full-size working automatic telpher. The car runs backwards and forwards on a rail 40ft. long, and is controlled by a contact lever from any desired point. On arrival at the front end of the rail it lowers the skip, for which a loaded one is substituted.

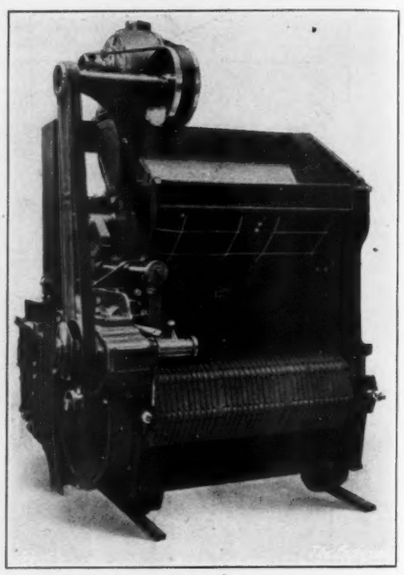


Fig. 8—LINK-CHAIN GRATE STOKER

The latter is then raised and conveyed to the unloading station, where it tips its contents and returns automatically to the loading point. Here it remains until the man in charge again switches on the current for operating the lifting gear, when the skip is again raised.

Felber, Jucker and Co., Limited, Peter-street, Manchester, show a portable building suitable for an office or similar structure, which is constructed throughout of a material called "Asbestilite." This material is claimed to be fire-proof, sound-proof, and non-absorbent. It is made of Portland cement, reinforced with asbestos fibre and is extremely tough, while it is claimed to be unaffected by atmospheric conditions, acids or chemical fumes.

The exhibition will remain open until to-morrow—Saturday.

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AT a recent meeting of the Royal Society a paper was read on "Protection from Lightning and the Range of Protection Afforded by Lightning Rods," by Sir Joseph Larmor, F.R.S., and Mr. J. S. B. Larmor. It was pointed out that on modern ionic views discharge in the atmosphere should originate at a place of maximum intensity of electric field and spread both ways from it along a line which should be roughly the line of force. The explanation of branching, zig-zag and multiple lightning discharges was to be sought on these lines. The introduction of a narrow linear conductor could not sensibly disturb a steady field of force, and not at all if it was transverse to the field. Thus it would seem that the top of the building itself, not the lightning conductor, attracted the discharge, and that the function of a single rod could only be to lead it more safely away. But a number of rods distributed over the area of the roof, and effectively connected to earth by a conductor, could by their joint action lift the intensest part of the field from the top of the building to the region around their summits, and so obviate or much mitigate the danger of discharge from above to the building which they covered. Diagrams were given in illustration of a vertical field of force as distributed by vertical pillars of semi-ellipsoidal form and of various breadths, or by an earthed conducting region overhead such as might be originated by gradual discharge from a pointed rod.

## THE TWIN-SCREW STEAMER MISSANABIE.

ON the 22nd inst. Barclay, Curle and Co., Limited, of Whiteinch, successfully launched from their yard the large twin-screw steamer Missanabie, built to the order of the Canadian Pacific Railway Company for passenger and cargo service between Liverpool and Canada. The principal particulars of the vessel are :—Length, 520ft.; breadth, 64ft.; depth, 41ft.; gross tonnage, 13,000 tons; displacement, 18,000 tons; and cargo capacity, 400,000 cubic feet. Below the level of the main deck the space is devoted to general cargo, while three of the lower 'tween decks are fitted for the carriage of refrigerated merchandise. From the main deck upwards through six separate decks the entire space is devoted to passengers, accommodation being provided for 520 cabin passengers and 1200 third-class passengers, as well as for a crew of 300, making a total of 2020 persons. On the main or "F" deck—which is the lowest passenger deck—all the accommodation is portable, and can be removed at short notice. A large commissariat department extends the full width of the ship on this deck, and provides cold storage for the more perishable table supplies. On the upper or "E" deck are placed the dining saloons, the main saloon being forward, and the third class—which is in duplicate—placed aft. Between the two saloons the entire space amidships is occupied by the culinary department, with its attendant auxiliaries, the remainder of the deck space being taken up by third-class living-rooms. The shelter or "D" deck contains an overflow third-class dining saloon, the fittings of which are portable, and the room when not in use for this purpose can be used as recreation space. At the aft end is a ladies' room for third class. On the lower promenade or "C" deck, at the extreme aft end are the third-class entrance, smoking-room, and hospitals, at the forward end is another entrance house for third class, while extensive promenade space for this class is provided adjacent to these houses. The midship area is entirely occupied by cabin passengers in two, three and four-berth rooms. Immediately above on the upper promenade or "B" deck is the cabin smoking-room, with *café* verandah at the aft end and card-room adjoining. Amidships is the drawing-room and the lounge is at the forward end. On the boat or "A" deck, entering from the upper promenade deck, is the gymnasium; at forward end is a Marconi installation and a house containing the emergency dynamo, which is entirely independent of the main propelling machinery.

The boat deck is entirely set aside for the storage and working of boats, of which there are sufficient for all on board, thirty-two boats in all being carried, one of which is a motor lifeboat. The launching arrangements have received a considerable amount of attention. The majority of the boats are in nests of two or three, and the davits in this case have a mechanical contrivance which enables the boat to be launched though the vessel may have a considerable list. In addition, two sets of Babcock and Wilcox davits are fitted, which, in conjunction with a tramway, render it possible to launch the lifeboats from either side of ship. There are no collapsible lifeboats on board, all being rigid open lifeboats.

The heating and ventilating system consists of two distinct methods whereby it is claimed that every space on board is ensured of a sufficiency of heat and fresh air. There is first a "thermo tank" system supplying heated air and designed to maintain an even temperature of 65 deg. Fah. even in the coldest weather. Secondly, there is a combined system of steam heating and warmed air, this system being also sub-divided into two separate and distinct methods used in conjunction with one another. The first sub-division makes use of live or exhaust steam at a pressure not exceeding 5 lb. per square inch, circulation being maintained by means of a vacuum at the exhaust end of the system. A range of piping is fitted, with radiators at convenient points, each apartment having an individual control valve. The second sub-division is again divided into two independent methods, viz., a warm air inlet and an extraction plant. Each system is intended to provide an air change of 1000 cubic feet per occupant per hour in living-rooms, eight changes per hour in dining saloons, and sixty changes per hour in galley space.

The electric lighting system comprises over 1300 lights, special attention being paid to the lighting of the boat positions. The electric power supply is also extensive, comprising fans, lifts, barbers' equipment, printing, submarine signalling and galley outfit. The generating plant consists of three sets of Greenwood and Batley's De Laval type turbines coupled to direct-current generators, the output of each set being 100 kilowatts at 100 volts.

All water-tight bulkhead doors are electrically operated, and can be closed simultaneously from the bridge. The cargo-handling arrangements are extensive, there being three derricks and two winches to each hatch, and, in addition, at No. 2 hatch there is a lattice girder heavy derrick capable of dealing with weights up to 25 tons. Steam steering gear is fitted on the lower deck well below the water-line, with a reserve gear also operated by steam. The propelling machinery consists of twin sets of quadruple-expansion engines, balanced on the Yarrow, Schlick and Tweedy system, steam being supplied by eight single-ended boilers working at a pressure of 215 lb. per square inch. It is anticipated that this vessel will have a sea speed of 16 knots on service.

## THE BIRTHDAY HONOURS.

THE names of a good many engineers appear in the birthday honours. The earldom conferred on Lord Kitchener heads the list, and it is hard to imagine an honour more richly deserved. Among those to be created Knights we notice Mr. Thomas Kirke Rose, who has been chemist and assayer at the Royal Mint for some twelve years, and Mr. John F. C. Snell, who is the next President of the Institution of Electrical Engineers.

In the Military Division of the Order of the Bath Colonel (temporary Brigadier-General) David Henderson, C.B., D.S.O., Director-General of Military Aeronautics at the War-office, has been created a Knight Commander, while Colonel Alexander William Roper, chief engineer, South Africa, has been made a Companion of the Order. In the Civil Division Mr. R. A. S. Redmayne, C.B., the chief inspector of mines, Home-office, has been made K.C.B., and Mr. W. H. Whiting, superintendent of construction accounts and contract work, Admiralty, has received his C.B.

In the Colonial-office list appears the name of Lieut.-Col. G. L. Eyles, C.M.G., M. Inst. C.E., consulting engineer for railways to the Crown Agents for the Colonies, who has been made K.C.M.G., and in the Foreign-office list that of Mr. Murdoch Macdonald, C.M.G., M. Inst. C.E., Under Secretary of State for Public Works, Egypt, who has been granted the same step.

In the Order of the Star of India Colonel Sidney Gerald Burrard, F.R.S., Royal Engineers, Surveyor-General in India, has been advanced from C.S.I. to K.C.S.I., while Mr. Michael Nethersole, Public Works Department, Inspector-General of Irrigation, Government of India, and Mr. Walter Gunnell Wood, A.M. Inst. C.E., chief engineer and secretary to the Government in the Public Works Department, Buildings, Roads, and Railway Branches, United Provinces, have both been created C.S.I.

In the list of the Order of the Indian Empire five names appear. These are those of Mr. Philip Glynn Messent, M. Inst. C.E., chief engineer to the Bombay Port Trust; Mr. Frank Currie Lowis, Public Works Department, executive engineer, Seniku-Htawgaw road extension, Burma; Mr. Richard Meredith, Indian Telegraph Department, Director of Telegraphs; Mr. R. H. Tickell, M. Inst. C.E., Public Works Department, chief engineer, Central Provinces, and lately superintending engineer, Swat River Canals Circle, North-West Frontier Province; and Dr. Thomas Summers, M. Inst. C.E., late Bombay Public Works Department. All these gentlemen have been created C.I.E.

In the Royal Naval Reserve Messrs. James Edgar Wimshurst and Roderick Morrison have been appointed Honorary Chief Engineers.

In the Royal Flying Corps Captains (and temporary Majors) George H. Raleigh, Essex Regiment; John H. W. Becke, Sherwood Foresters; John H. Salmond, King's Own Royal Lancashire Regiment; and Charles A. H. Longcroft, of the Welsh Regiment, have all been promoted by brevet for services in connection with the Military Wing of the Corps.

Finally, Mr. John Trump, M. Inst. C.E., lately Director of Public Works, Federated Malay States, and Mr. William M. Vaudin, Superintendent of Public Works and Surveys in the Colony of Seychelles, have been made Companions of the Imperial Service Order.

# CENTRIFUGAL PUMP FOR HULL JOINT DOCK

W. H. ALLEN, SON AND CO., LIMITED, BEDFORD, ENGINEERS

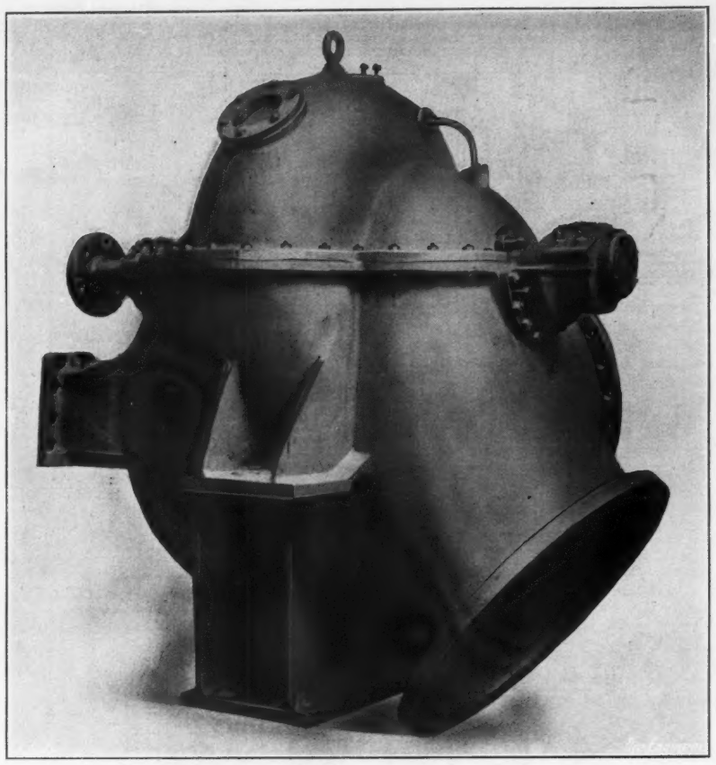


Fig. 8

## HULL JOINT DOCK.

No. II.*

IN last week's issue we referred briefly to the mechanism for operating the gates of the main lock which is of novel construction. The lock is 85ft. wide and is controlled by three pairs of gates, as shown in Fig. 11. The gates are opened and closed by

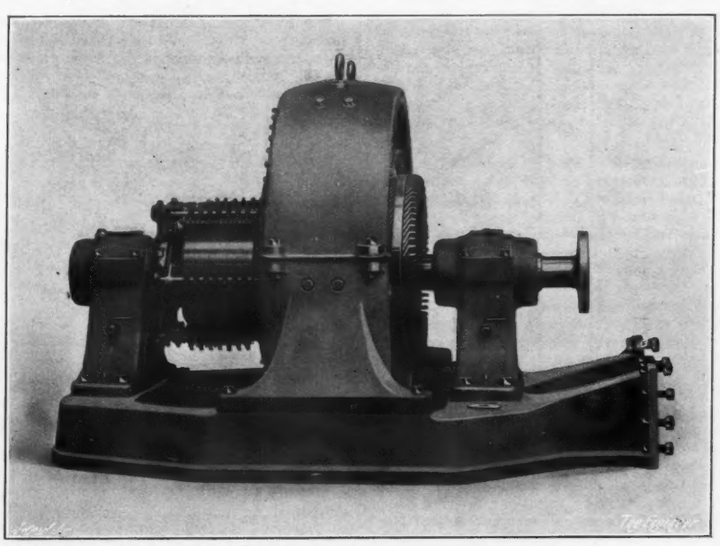


Fig. 9—MOTOR FOR DRIVING CENTRIFUGAL PUMP

* No I. appeared June 19th.

machinery made under the patent of Mr. T. L. Norfolk, of Hull, by the Hydraulic Engineering Company, Limited, Chester, which is the sole licensee. Details of the mechanism are given in Fig. 12 and Fig. 13 on page 703. Each pair of gates is operated by two complete sets of appliances, one for each leaf, through the medium of a moving strut, one end of which is hinged to the leaf by a pin connection at a point corresponding approximately to the centre of pressure due to the head of water. By attaching the strut to the leaf at this point less power is required to operate the gate, and as the strut lies behind the leaf no loss of draught of water in the entrance to the lock is incurred by operating chains or ropes lying across the entrance sills. The other end of the strut is supported and guided by means of a sliding crosshead free to move backwards and forwards on slide bars fixed to the walls of a tunnel formed in the side wall of the entrance. The struts themselves are built up of steel plates riveted up so as to be absolutely water-tight, and each has been tested to an internal hydrostatic pressure of 25 lb. per square inch. They are actuated by a steel wire rope fixed to the crosshead end and carried up to the quay level by fairleads fixed at the ends of the tunnel, then round a winding drum, and back by other fairleads to the end of the strut. These drums are carried by side frames on a bed-plate. The wire rope is secured to the drum in such a manner that the strut moves backwards or forwards according to the direction of rotation of the rope drum, thus opening or closing the gate. This method of construction enables the thrust of the strut to be applied at the most advantageous point while allowing the driving machinery and gearing to be above the level of high water.

The rope drums are each driven by means of a three-throw single-acting oscillating reversing hydraulic engine, shown in Fig 14, capable of developing 25 brake horse-power at 110 revolutions per minute with a water pressure of 700 lb. per square inch. The engine is geared to the drum by a clutch and machine-cut gear wheels. Each cylinder is controlled by an independent slide valve actuated by a lever fixed to the cylinder trunnion, and reversing is effected by a servo-motor, which moves a seat in each engine working valve, causing the ports to be reversed. That is, the exhaust port is made to open to pressure and the pressure port to exhaust. In case of breakdown of the engine or failure of the pressure supply provision is made for operating the machines by means of capstan bars and manual power. Each set of gate machinery is controlled by two levers, one actuating a valve controlling the pressure supply and the other a valve acting on the servo-motor.

Four sets of similar machinery have been supplied for the graving docks, the entrances of which are 72ft. and 66ft. wide. The engines for operating the gate machinery were designed and built by the Hydraulic Engineering Company, Limited, Chester, which also constructed the gate machinery from designs by the Hull Joint Dock engineers.

The general arrangement of the pumping plant for the graving docks is shown in Fig. 10, while Figs. 8 and 9 are general views of one of the pumps and electric motors respectively. The complete pumping equipment has been supplied by the firm of W. H. Allen, Son and Co., Limited, Bedford, to the specification of the joint engineers, Messrs. T. M. Newell and Mr. R. Pawley. The plant consists of two main centrifugal pumps, a centrifugal drainage pump, and a two-throw single-acting charging pump, all operated by electric motors. The main pumps have suction and discharge branches 42in. diameter, and each is capable of discharging a mean quantity of 36,000 gallons of water per minute against a head of 40ft. These pumps revolve at a speed of from 375 to 416 revolutions per minute, and each absorbs a maximum of 390 brake horse-power. The pump casings and discs are of cast iron and the steel spindles run in ring lubricated bearings arranged outside the casing. The suction and discharge pipes merge into a main discharge pipe 60in. diameter.

Hydraulic sluice valves are fitted on the suction and discharge sides of the main pumps and arranged so that each main pump may draw water from either dock as may be required. These sluice valves are 42in. in diameter and are arranged to work with water at 750 lb. per square inch pressure. They are provided with controlling valves. A retaining valve, 42in. diameter, is fitted on the discharge side of each

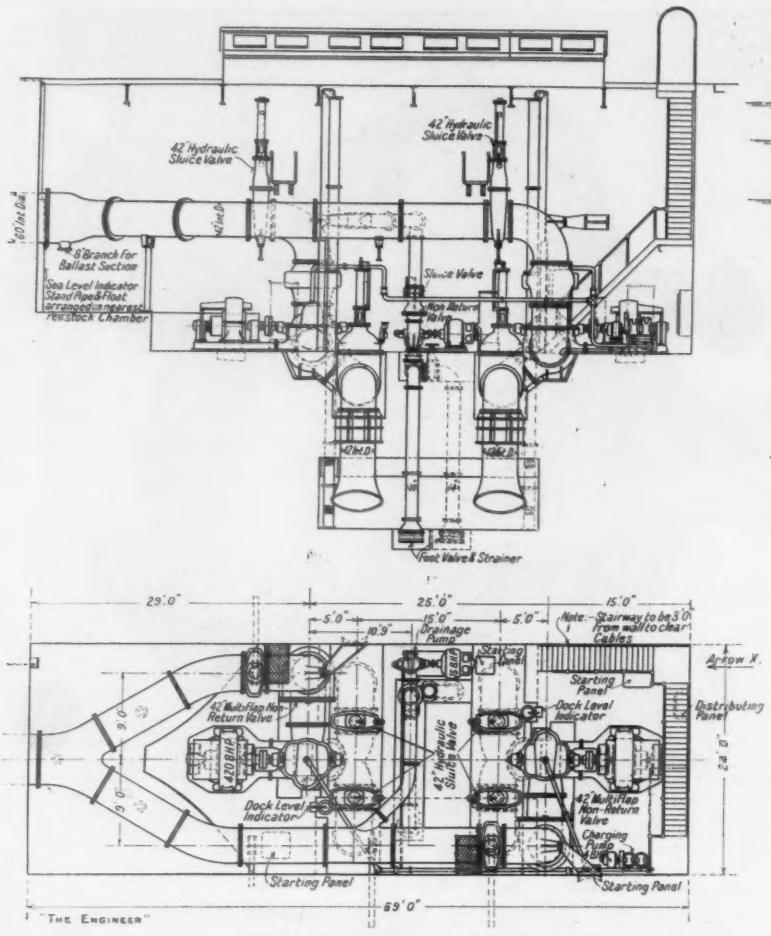



Fig. 10—ARRANGEMENT OF PUMPING PLANT

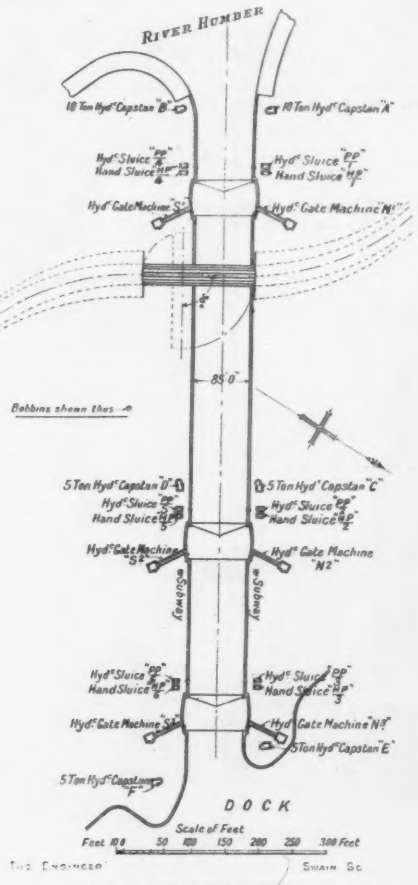



Fig. 11—ENTRANCE LOCK

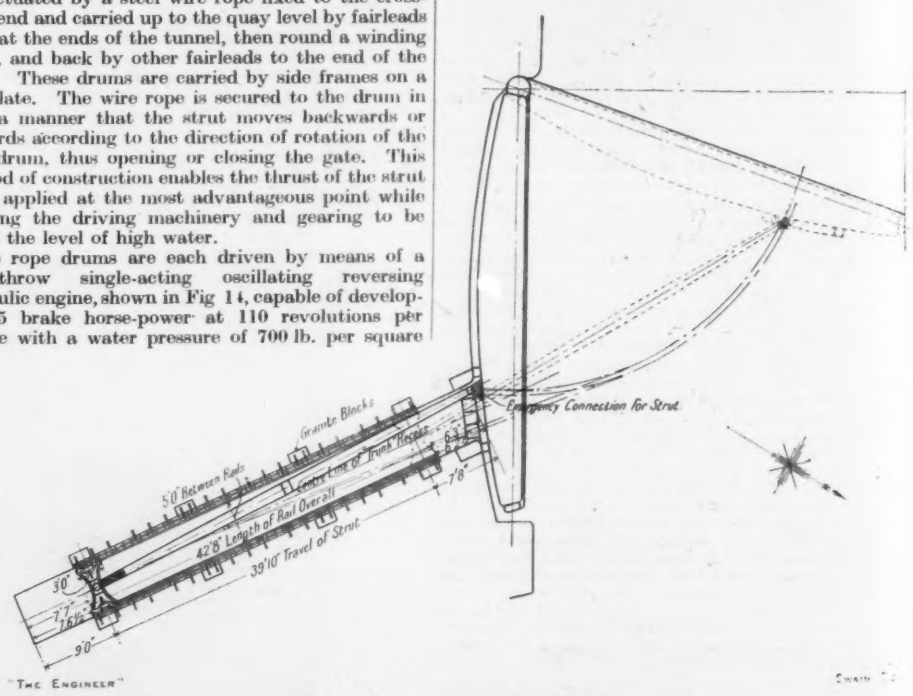



Fig. 12—DOCK GATE OPERATING MECHANISM

of the pumps, and these are of the multi-flap type with cast iron casings. Water level indicators have been fitted to show the level of the water in the graving docks and outside the docks. The drainage pump has suction and discharge branches 14in. in diameter, and delivers 3000 gallons of water per minute against a total suction and delivery head of 54ft., the speed being 1100 revolutions per minute. The energy absorbed by the pump under these conditions is 70 brake horse-power. The pump casing is of cast iron, the disc of gun-metal, and the spindle of manganese bronze.

The charging pump has barrels 8in. diameter by 5in. stroke, and is capable of charging the main and drainage pumps and pipework in a few minutes. Air vent pipes have been provided in order to free the suction culvert from air.

The main motors are of Allen's open type, fitted with a protective shield to prevent water dripping on to the windings. Each motor develops a full load output of 420 brake horse-power when running at 375 to 416 revolutions per minute and supplied with continuous current at a pressure of 440 volts. The drainage pump motor is of the semi-enclosed type and develops 75 brake horse-power at 1100 revolutions per minute. The motor for driving the charging pump is of the same type and drives the pump at a speed of 750 revolutions per minute. Each motor is provided with complete switchgear consisting of an enclosed ironclad pillar. The pillars are equipped with a 420 horse-power 440-volt multipolar lever starter consisting of a series of edgewise type switches. The starter is operated step by step by means of a slow-motion ratchet type handle. This handle actuates a double-pole circuit breaker of the magnetic blow-out type interlocking with the starter, so that the breaker can only be put on when the starter is " off " and is tripped, and cannot be put on again until the starter is returned to the " off " position in the event of the attendant failing to complete the operation of starting. The drainage pump and charging pump motors are also supplied with their own switch-gear.

Figs. 15 and 16 on page 704 represent one of the twenty-five 3-ton electric jib cranes, which are being built by Royce Limited, Trafford Park, Manchester. In these cranes each of the motions of hoisting, luffing, slewing, and travelling is fitted with a separate motor, and the jibs are fitted with the Musker-Davidson patented balanced luffing gear, the special advantage of which is that the load is kept in a horizontal position during the inward luffing of the jib, and not lifted as in the ordinary crane. A comparatively small motor is therefore only required for this motion, and a quick speed also may be adopted to suit the conditions. The general design of the crane is clearly indicated by the illustrations. The maximum radius of the jib is 50ft., minimum 20ft., the luffing speed at the hook 150ft. per minute. The hoisting speed with 3 tons load is 150ft. per minute and 1½ tons 250ft. per minute. The slewing speed at the hook is 400ft. per minute, and the travelling speed 30ft. per minute. The height from the crane rails to the point of the jib at the maximum radius is 80ft. The travelling rail centres are 15ft. apart and the wheel-base is 19ft. The electrical equipment is made for 440 volts continuous current, the hoisting motor being 45 brake horse-power, the slewing motor 5 brake horse-power, and the luffing and travelling motors each 8 brake horse-power. All the motors are designed on a basis of six hours' rating and are of the totally enclosed fan ventilated type, while the

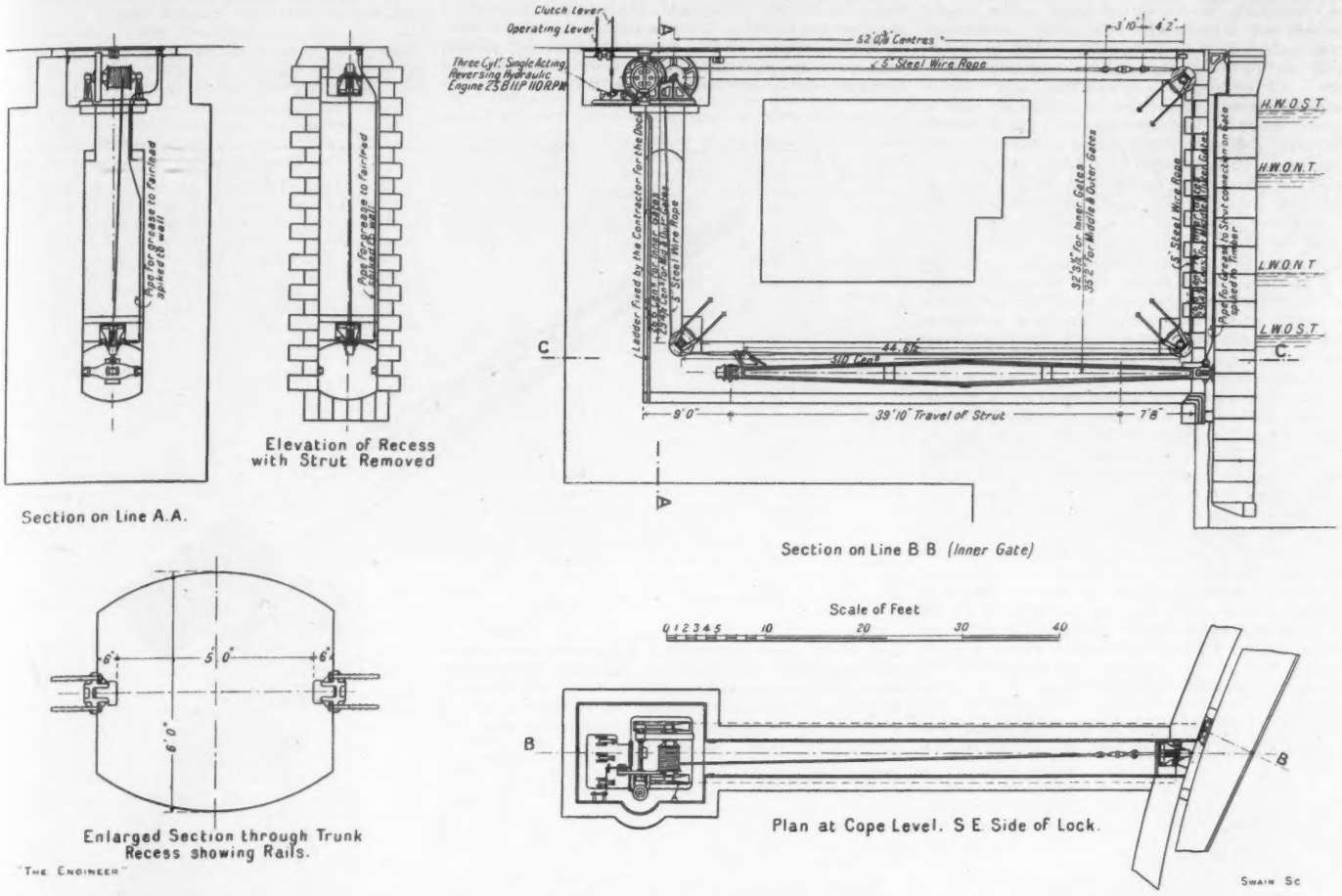



Fig. 13—DOCK GATE OPERATING ARRANGEMENTS

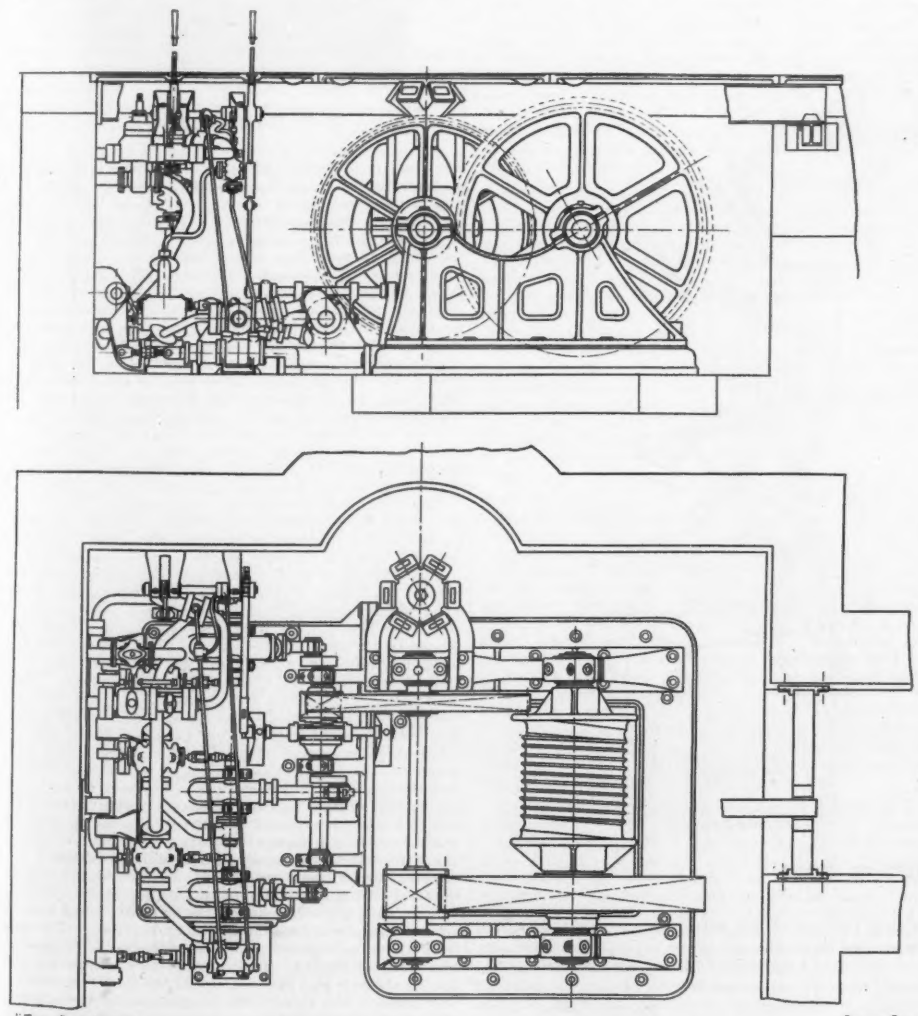



Fig. 14—DOCK GATE OPERATING MACHINERY

controllers are of the tramway type, of very substantial make to stand rough usage.

Each crane is supported on four cast steel travelling wheels with single flanges on the inside. The travelling motion only is fitted with hand gear. Automatic electrical safeguards against overrunning in either direction are provided for the hoisting and luffing motions. All the toothed gears on the crane—except the motor pinions, which are of raw hide—are of cast steel, machine cut throughout. Each motion is fitted with an electrical brake, and in the case of the hoisting motion a powerful foot brake is also provided on the barrel shaft and is used for quick lowering without current. In such circumstances the electrical brake is held off by a hand release device. The gear for the motions of hoisting, slewing, and luffing is carried on a central revolving mast, which is pivoted and supported at the foot in a substantial cast steel footstep bearing and at about the centre of its length by a roller path. The jib is carried at the top end of the mast by a heavy fixed shaft and is balanced by cast iron weights fixed at the tail end of the jib structure.

The lower portion of the crane structure is of steel plates, and the whole is riveted together and well stiffened along the edges by double angles and at the corners by substantial gussets and diaphragms. The superstructure is arranged to form a motor-house and encloses all the hoisting, slewing, and travelling gear. The position of the driver's cabin in front of the mast and under the jib is convenient for enabling him to obtain a full view of the whole of the motions of the hook and load.

As a test of stability carried out by the makers of the cranes, a load of 6 tons was suspended on the hook at the maximum radius of the jib and the jib moved round to various positions. There was no perceptible lift in the structure or wheels and no additional support was obtained from either jacks or rail clips.

Hull claims the third place in the United Kingdom with regard to the export of coal, which now reaches 7,000,000 tons per annum, as well as from the standpoint of general trade. Four hundred collieries have access to it by rail, and it is the nearest of the larger ports to the coalfields of Yorkshire, Nottinghamshire, and Derbyshire, which yield annually 70,000,000 tons of fuel. Altogether there are forty separate coaling berths at the Hull docks, with a total maximum shipping capacity of 15,000 tons per hour.

In view of the ever-increasing use of liquid fuel, the directors of the Hull and Barnsley and North-Eastern Railway Companies recognised the importance of providing ample means for storing and handling oil in large quantities. At Salt End an oil jetty has recently been completed, extending into the river Humber for 1500ft. It has a depth of water of 30ft. at L.W.O.S.T., and the largest oil-carrying vessels can thus come alongside at any state of the tide and discharge direct into storage tanks through pipe lines laid down along the jetty. A considerable area of land has been set apart for the erection of these storage tanks and the establishment of allied trades, and we are informed that several of the largest oil distributing firms have already acquired sites and commenced operations at this port.

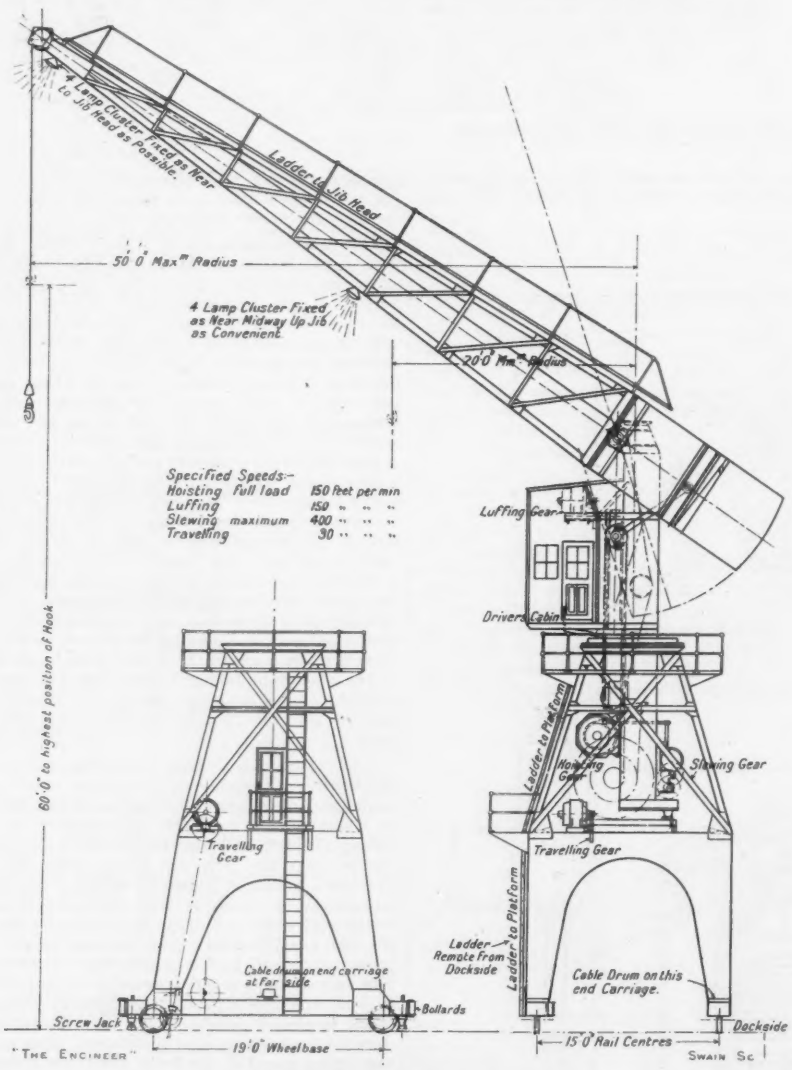



Fig. 15—THREE-TON ELECTRIC JIB CRANE

In that portion of our article of last week in which we described the hydraulic plant supplied by Hathorn, Davey and Co., Limited, of Leeds, we stated that the alternative supply of water for this plant was obtained by means of electrically driven pumps taking water from the dock, and that these pumps were provided by W. H. Allen, Sons, and Co. We should have said that the pumps were, like the rest of this part of the work, made and fixed by Hathorn, Davey and Co., Limited. The pumps are direct driven.

## TWO RAILWAY ACCIDENTS.

As we briefly announced last week, a fatal accident occurred at the Great Western station at Reading on the 10th inst. An excursion train from the West of England to Windsor for Ascot races arrived on the up platform line, and the enginemen were changed. Soon after the fresh driver had taken charge, his fireman gave

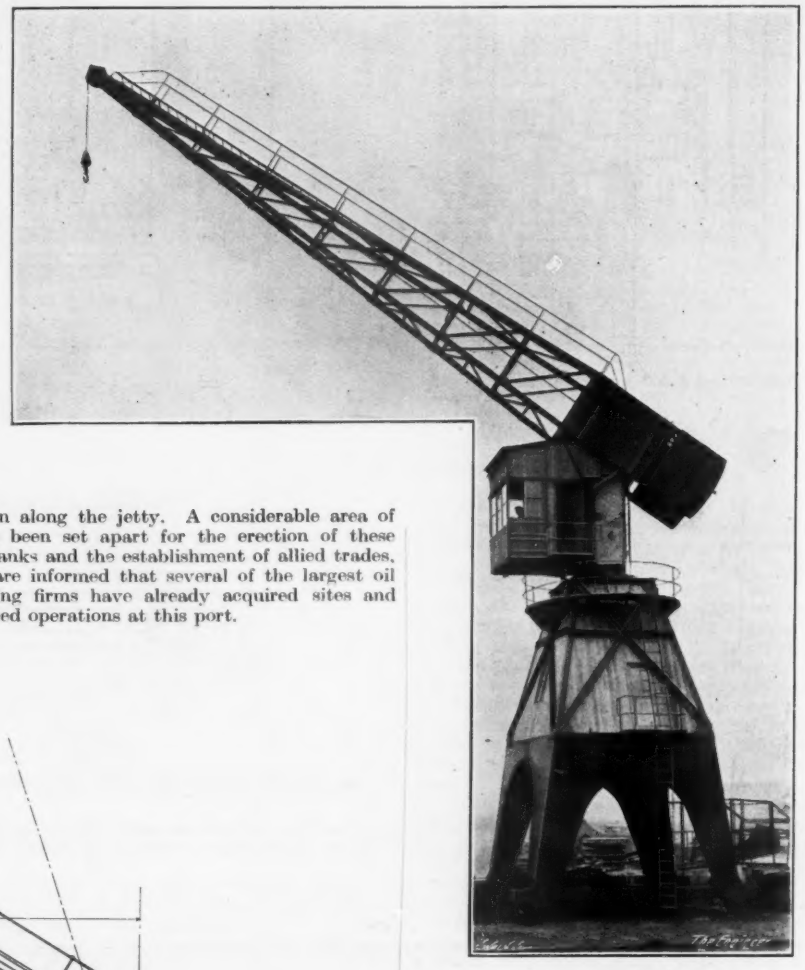


Fig. 16—THREE-TON CRANE

him the "right away" signal, and the man, looking ahead and seeing the inner home signal, near the signal box, and the starting signal, nearer London, at "clear," gave his engine steam and started. At this time an express from Worcester to London was approaching on the adjoining up main line, and it was for this train that the inner home and starting signals were "off." As the express could not be pulled up in time and as the special did not stop, the two trains met at the point where the up platform line is turned into the up main line. Both engines were derailed, the express engine eventually coming to rest on its right side across the South-Eastern and Chatham lines. The driver of the latter locomotive was so badly hurt that he died from his injuries. Otherwise the casualties were very minor. Colonel von Donop held his inquiry last Friday, but the point as to why the fireman gave the "right away" signal was not cleared up. It should be noted that on the Great Western Railway the engines are driven from the right side of the footplate.

The first fatal accident to a passenger in the United Kingdom since October 25th last, a period of nearly eight months, occurred on the 18th inst., near Carr Bridge on the Highland Railway, under tragic circumstances.

Carr Bridge is on the Aviemore–Inverness direct line, opened in 1898, which crosses the Cairngorm range. It is highly situated and the principal watercourse is the river Dulnain, of which the Batan is a tributary. About two o'clock on the afternoon of the day in question a storm of unusual intensity broke in the mountains, which caused the Batan to flood and to sweep trees, stones, and other *débris* before it into the arch under the main road until an upper bridge was blocked and a dam created. The weight behind the bridge broke it down, and the released water rushed down the gorge and round a sharp bend to the Batan-Gorm Bridge under the railway. Indications show that there was a depth of 20ft. of water under this bridge, and a breadth of about 150ft., which got behind the protection wall on the south side and behind both abutments. By the time the 11.55 a.m. train from Perth to Inverness reached the bridge it must already have been weakened, as the tender became derailed on the north side of the bridge, and the train, of course, stopped. Next to the tender was a horse box, and then came three bogie vehicles and a van. The bogie vehicles were more or less on the bridge, and, whilst there, the bridge collapsed. The middle coach was swept away by the stream, and the rear end of the first coach and the front end of the third were dragged downwards, but did not share the unfortunate fate of the middle vehicle. Several passengers were swept away by the flood, and five of them were unfortunately drowned. The Board of Trade has appointed Colonel Druitt to hold an inquiry into the disaster, and he has visited the scene during the present week.

## RAILWAY MATTERS.

WE learn on the highest authority that a rumour about the purchase of German locomotives by the Great Eastern Railway is wholly without foundation.

IN consequence of the conditions imposed by a Committee of the House of Commons in connection with the Bill promoted by the Great Northern and Metropolitan Railway companies for the acquisition and joint working by them of the Great Northern and City Railway, and for its extension to the Bank Station of the City and Waterloo Railway, the scheme has been withdrawn.

A ROPE railway, 75 miles in length, is to be put in operation in India. It will connect the rich country in the Vale of Kashmir with the plains of the Punjab over the Himalayas. The line, it is claimed, will be the longest in the world, the present longest being 22 miles and situated in Argentina. Sections will be 5 miles long, and most of the spans will be 2400ft. The steel towers, some of which will be 100ft. high, will be braced, and double 1¼in. cables, 9ft. apart, will carry the steel cars. The carrying capacity of these cars will be about 400 lb.

FOR shunting purposes at the Cleveland ore docks, with a view to avoiding the inclusion of the shunting engine among the cars being shunted, the Pennsylvania Railway has introduced locomotives which have the peculiarity that they do not run on the same lines as the cars they handle, but on narrow gauge parallel line. Each engine has an arm on each side which can be lowered by means of compressed air controlled from the cab, and acts as a pusher. The locomotives are of Baldwin-Westinghouse make and are 25 tons in weight. Power is obtained from two rails lying inside the rails on which the locomotives operate; these rails are protected by a wood covering.

IN reply to the representations of a Railway Improvements Committee—consisting of representatives of the Worcester City Council, the Worcester Chamber of Commerce, the Malvern Urban District Council, and the Malvern Improvement Association—and in pursuance of the conference between the Committee and the representatives of the Great Western and Midland railway companies, held at Worcester on March 17th, the Midland Railway has made welcome improvements in the train service between Malvern and Worcester on the one hand, and Birmingham and Bristol on the other. The suggestions made by the Committee to the Great Western Railway Company are still under consideration. The alterations and additions which the Midland Company has agreed to will be made in the July time-tables.

MAJOR PRINGLE'S report to the Board of Trade as to the collision at Canfield Place, near Marylebone, on April 26th, shows that the accident occurred under the circumstances related in our issue of May 1st. The report puts most of the blame upon Lucas, the pilot man, for allowing the single-line section to be occupied by a train without his being present; on Durham, the inspector, who took the assisting engine into the section without the pilot man's authority: and on Johnstone, the signalman, at Marylebone Goods Yard signal-box, for allowing this and for not giving definite information as to where the express had come to a stand. The driver of the assisting engine and the signalman at Canfield Place box are blamed for acquiescing in an irregularity. Major Pringle says that the accident illustrates particularly the danger in railway working of the policy of taking things for granted.

STEPS have been taken by the Metropolitan Street Railway, of Kansas City, to prevent newsboys and others from hanging on the back of cars with or without paying fares by the simple expedient of removing all equipment formerly used as a foothold by such violators of the company's rules, or, in some cases, by merely altering it. The drawbar which has extended underneath the car at the back has always been a friend of the impecunious or miserly passenger. The mechanical department of the railway has placed the drawbar on a pivot, and it is now swung far around and underneath the car, where it is hung on a hook when not in use. The rear bumper, the only other support available for rear-platform passengers, has been covered with a concave, cast iron plate, effectively preventing anyone from riding without paying a fare, and incidentally reducing the number of accidents on the road.

THE British-Vice-Consul in Hayti states in his annual report that the bad state of the roads in the capital, combined with the lack of care given to the upkeep of the motor cars which began to be imported in 1912 from the United States, has resulted in the disappearance of all but two or three. Until better traffic conditions exist in the towns it is unlikely that the experiment of importing these costly articles will be repeated. The completed sections of the National Railway are being run with the smallest amount of service compatible with the contract, as in no portion are the receipts sufficient to pay for operating expenses. The line from Cape Hayti has been extended to Bahon, whence some mahogany has been shipped, but the disturbed state of the north has prevented any serious development. As was anticipated, the receipts on the Port-au-Prince–St. Marc section are entirely negligible, both freight and passenger service being practically unused.

ACCORDING to the *Electric Railway Journal*, Mr. Ralph H. Beach, of New York, has recently brought out a new type of gas-electric self-propelled car in which the engine requirements are kept to a minimum by the use of a storage battery auxiliary. In the event of failure of the engine from any cause, the battery is always available and ready for at least 50 miles. Mr. Beach believes that the principal defect of other types of self-propelled cars is that they must keep in continuous use an engine capacity which in reality is required only during the acceleration and gradient-climbing periods. It is asserted that the use of the battery will therefore make it possible to cut down the engine equipment considerably. It is calculated that on level running with the car stopping each 5 miles 4.9 per cent. of the total energy required to drive the car will be derived from the battery, and consequently 95.1 per cent. of the energy will be furnished by the engine direct, whereas the battery would do 30.1 per cent. of the work on a 5 per cent. gradient.

## NOTES AND MEMORANDA.

THE electrical conductivity of copper depends upon the total amount of impurities, and not upon any one element. This is why the conductivity test is so valuable in determining the purity of copper. The aggregate of all impurities is shown, and thus the purity of the copper indicated. Amounts of impurities that will defy detection, or would never be known to exist by chemical analysis are found when the electrical conductivity test is applied.

PLANT for the impregnation of pitwood with a liquid known as "Axol" has recently been installed in connection with the Courcelles-Nord collieries in Belgium. The preparation is described as a solution of oxide of copper and zinc in ammonia, with a certain percentage of benzol. The wood is put in a boiler and submitted to a vacuum for twenty minutes. The "Axol" is then introduced and forced into the timber at a pressure of 10 atmospheres, the operation being continued for another twenty minutes. It is claimed, says the *Iron and Coal Trades Review*, that pitwood thus treated gives off no smell, has no smearing outside surface, and is impervious to the effect of damp or heat.

BEFORE the American Institute of Electrical Engineers Messrs. C. S. McDowell and D. M. Mahood read a short time ago a paper on "Electric Heating as applied to Marine Service." A comparison of convector and radiant heaters is given, the proper use of each type is shown, and the conclusion drawn that for space heating on shipboard with metal decks and bulkheads, the convector heater is most efficient. Curves are given showing results obtained on tests to determine the best type of heater for shipboard and desirable features of heater are indicated. With low cost of electricity on shipboard, electric heating compares favourably in cost of maintenance with steam heating. It interferes very little with the lighting load, thus increasing the load factor, and seldom requires extra generator capacity.

IN Turkey, where cement is not used or hardly known, a substitute has been found that has met with rather good results when applied in exposed places, in filling crevices in water pipes, covering joints in stone floors, in fountains and for numerous other purposes where cement would be required. The mixture is as satisfactory in water as in exposed places, but it must be allowed to become thoroughly dry before it is submerged. The mixture is slaked lime, linseed oil and cotton fibre. Generally a hollowed-out stone is used, although a flat, hard surface will answer, and the process is started by pouring the oil on a handful of cotton, after which the lime is dusted in. It is then kneaded until the whole is thoroughly mixed and about the consistency of dough. The more it is kneaded the better it becomes.

IN a paper read before the Aeronautical Society of Great Britain Lieut.-Col. F. H. Sykes says: "Some aeroplanes deteriorate more rapidly than others by being out in the open, but there is no doubt that they all deteriorate to a very considerable extent, and if the climate is damp or otherwise unfavourable new planes will be required after each period of manœuvres. More attention to varnishing the wood and exposed metal would probably well repay time given. A really good water-proofing 'dope' is a want. An entirely efficient very light portable tent is still lacking. If the ideal in this respect is obtained considerable expense and deterioration of aircraft might be obviated by at once sending the tent shed to the breakdown instead of having to go through the laborious process of dismantling the broken-down machine, loading it on a lorry, and bringing it in."

A CONTEMPORARY points out that in fire after fire it has been demonstrated that unprotected ironwork only helps to destroy buildings "by expanding and pushing out the walls or yielding under the heat and pulling them down." After referring to slow and costly experience of so-called methods of fire-proofing, our contemporary makes the following remarks upon reinforced concrete:—"Whatever may be the opinion of architects as to its adaptability, there is no doubt that its proved fire-resisting and other desirable qualities ought to secure its use for the structural portion of all large buildings. We are afraid, however, that safety alone is not a sufficient inducement to adopt it, and not until architects and capitalists find that it is really an economical method of construction and makes a good foundation for adornment shall we see it as widely used as we think it should be."

THE recovery of tin from tin-plate waste has become quite an important industry. There are three general methods of separating the tin—mechanical, chemical and electrolytic. The most important of these methods is the last. The electrolyte employed is usually hot caustic soda, loosened chips of tin-plate packed in wire baskets act as anodes, while the iron bath walls or iron plates suspended therein act as cathodes. The average tension is said to be 1·5 volts. When separated the tin is spongiform. Other methods of electrolytic de-tinning are in use in Germany, among them an alkaline method which is said to offer great advantages over the acid methods formerly used and a chloride method applied by Lambottle, of Brussels; this is the most extensively used. The principal requirements for the successful application of it are absolute exclusion of moisture during the process of de-tinning, the avoidance of an unduly high temperature, and proper washing of the de-tinned waste.

PROFESSOR Paul Sabatier recently delivered at King's College the first of his course of lectures on "Catalysis." Catalysis, he pointed out, was the term applied to a certain class of chemical processes provoked by the presence of substances that seemed at first inactive in reaction. These might be either solids, liquids, or gases. In the latter half of his lecture he considered the applications of catalysis in the arts. Considering it from the point of view of metals, he drew attention to the way in which nickel could fix hydrogen and transfer it to other substances. It could, for instance, starting with benzine, increase the hydrogen present in the molecule. The same principle was applicable for the preparation of synthetic rubber. Both carbon monoxide and carbon dioxide could by means of it be transformed into methane, and in this way water gas could be changed into a gas that would give high temperatures and also could be transformed into a gas that was more efficient for lighting purposes.

## MISCELLANEA.

EVERYTHING in a new pigsty outside Randers, Denmark, which has two storeys, and accommodates 1500 animals, is worked by electricity. There are railway lines all over the sty, and only three men are needed to do the work, which includes grinding corn and fetching milk, foodstuffs, and young pigs from Randers.

THE Birmingham Chamber of Commerce has given its patronage to a cinematograph film of Birmingham industries which is being prepared by the Moving Picture Exhibition of British Industries. The film, which will be about 8000ft. long, will be exhibited in eighty-eight cities in North and South America, Europe, Asia, North and South Africa, India, Australia and New Zealand.

WE learn from the *Electrician* that experimental installations of check meters at telephone subscribers' instruments are now being tried in a few London offices by the General Post-office telephone officials. These are purely experimental at present, the idea being to avoid the constant disputes as to the number of calls made between subscribers and the exchanges.

AT the meeting of the Council of the East London College held on June 22nd, it was announced that the Court of the Drapers' Company had resolved to defray the cost of the erection and equipment of the new chemical laboratories of the College. The cost will amount to approximately £15,000, and it is hoped that the laboratories will be available for the use of students at the commencement of the new session in October next.

AS a man remains in the employ of a firm, states the *American Machinist*, so his particular skill on his job increases. This skill does not represent an item of cost to the firm, but it does represent an asset; his skill and knowledge are direct money value to the shop where he is employed, and his departure diminishes the capital of the firm by that amount. This value can never be expressed directly in pounds, shillings and pence. If it could be, many a manager would think twice before laying off men.

ACCORDING to the *Electrical Review*, further progress has been made by the French naval officers, Commander Colin and Lieutenant Jeance, who have been carrying on experiments in wireless telephony for the past five years. Conversations have been very successfully and efficiently carried on over a distance of 150 miles. It is understood that the inventors have succeeded in developing a transmitter which can be depended upon to maintain constancy of pitch, enabling accurate tuning to be effected. The apparatus is made by the Compagnie Générale de Radiotélégraphie.

"THE Negro and Labour" is the subject of an article in the *Arena*, and the writer says that it is always said, "There is nothing under the sun lazier than a negro"; but it must be remembered that laziness is a very relative matter. The negro has always worked just enough to live in comfort. Before the coming of the white man altered his ideas of comfort he could supply his needs with practically no labour, the banana tree supplying him with everything. He only works now in order to obtain those objects which he sees the white man use and which he covets. He does not work for work's sake, but simply to supply his needs, and who can blame him for that?

WHAT is termed an explosion of sewer gas completely wrecked a small screen-house at the north-west end of the Metropolitan sewage pumping station near Chelsea Bridge, East Boston, about noon on June 1st, smashing windows, strewing the wreckage for 70ft. around, and causing the death of three attendants and the serious injury of several others. The house, which was about 25ft. square, was strongly built of brick and steel, as is evidenced by the fact that several large sections of the walls were blown some distance without breaking. The station deals with about 200,000,000 gallons of sewage per day, about one-third of the total amount for the city of Boston.

IN view of the age and present value of the hospital ship Maine, which went ashore some days ago, and after consideration of the probable cost of salving the ship and towing her to a port for repairs, together with the very heavy expenditure that would necessarily be incurred in making her seaworthy and fit to resume her duties for fleet hospital work, it has been decided to abandon efforts to salve her. It will be remembered that the Maine was subscribed for by the women of America, and presented to the nation by the Atlantic Transport Company during the Boer War. To preserve these memories, the Mediator, which is now fitting out as an additional hospital ship and will be completed as soon as possible, will be re-named Maine.

IT is stated by the *Bollettino del Ministero delle Colonie* that the means for the production of artificial ice in the town of Tripoli are considerably in excess of the present requirements. In consequence of this, the proprietors of the three ice factories which have been working since last year have resolved to close two of their works for the present, in order to limit the output and maintain the retail price of 10 centimes per kilogramme (4s. per cwt.). The factories, together with the cold storage establishment, are capable of producing 30 tons of ice per day. The refrigerating plant, which is of the latest modern type, was constructed almost entirely in Italy and Germany, but the engines of one factory were supplied by a Manchester firm.

THE Public Safety and Accidents Investigation Committee of the Royal Aero Club, in a report on the fatal accident to Mr. Philippe Marty, when flying a Morane-Saulnier monoplane at the London Aerodrome, Hendon, on Sunday, April 26th, states that the accident was due to loss of flying speed resulting in a nose dive so close to the ground that recovery was impossible. "The fatal injuries to the aviator were caused by his body being thrown violently forward and his head striking the part of the structure in front of him. The Committee is further of opinion that some form of quick-release safety belt of an elastic nature might be devised which, without hampering the aviator's ordinary movements, would restrain such violent forward motion." The Royal Aero Club has, as a consequence, decided to offer a prize of £50 for the most suitable form of safety belt.

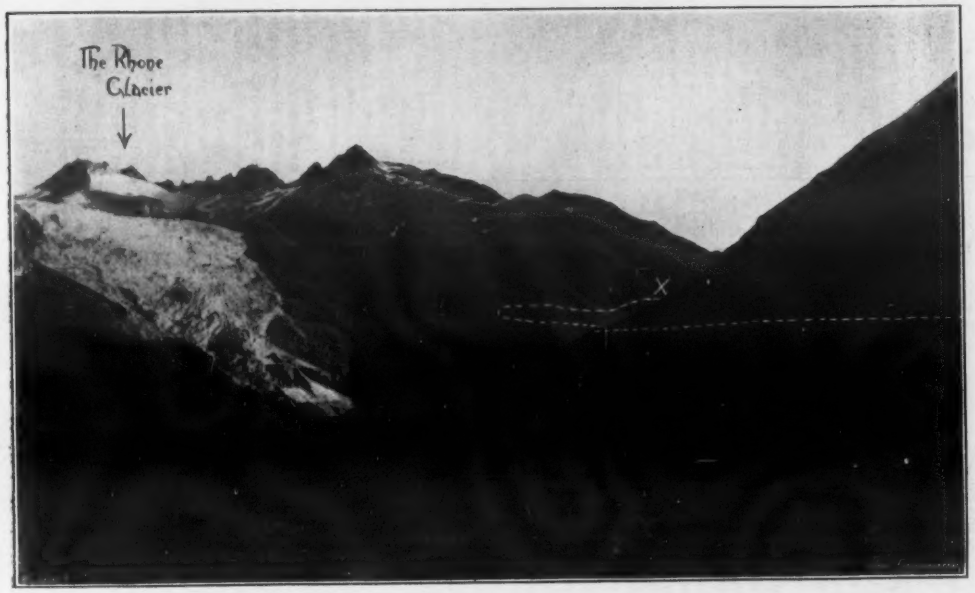
# THE FURKA RAILWAY, SWITZERLAND

(*For description see page* 694)

THE TUNNEL WORKS

GLETSCH PORTAL OF THE FURKA TUNNEL

REALP PORTAL OF THE FURKA TUNNEL

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# THE ENGINEER.

*JUNE* 26, 1914.

### The Railwaymen's Programme.

THE conference of railwaymen which has just come to an end was of more than ordinary moment. In a few months the agreements with the companies terminate and the renewal or reconstruction of the conciliation boards will have to be faced. The attitude of the men has long been of an almost threatening nature, and the fear of serious trouble in the autumn cannot be cast behind us. The Amalgamated Society of Railway Servants is in a much stronger position than it has ever been, and its amalgamation with another transport union and the Miners' Federation in what we described some months ago as a triple alliance of labour has far more than trebled its strength. The conditions, then, are such as to make the conference of unusual significance, for it may be estimated, in round numbers, that over one and a quarter million of men are affected by its decisions.

We have ante-dated by a few days the triple alliance, for although its ratification was a foregone conclusion, it lay with the conference itself to accept or reject it. This it did with enthusiasm, and employers have now to face the formidable amalgamation of the three railway unions—effected more than a year ago—the Transport Workers' Union, and the Miners' Federation. The power in the hands of such a body is enormous. It is dangerous to shut our eyes to that fact or to allow ourselves to be persuaded that for the very reason that it is so powerful it will be tolerant and reasonable. In individuals great strength is frequently combined with sweetness of disposition, but with amalgamations of men the tendency is rather in the other direction. Mr. Bellamy, in his presidential address, made a speech which was excellent and moderate. But Mr. Bellamy is only a leader, and we know that the duty of leaders is, nowadays, to follow the rank and file. There is no probability that moderate counsels will be unanimously acceptable. A large body of men is already restless, is ready to strike, and at any moment may carry the moderate party off its feet. Mr. Bellamy probably knows that the programme which he outlined—the eight hours' day and a five shillings a week rise all round—cannot be acceded by the companies. But he put it forward none the less because he had to express the general feelings of the meeting or lose its sympathies. If the men, as they may well do, hold Mr. Bellamy and the delegates at the conference to that programme, it is difficult indeed to see how trouble is to be avoided. To expect the triple alliance to restrain its power is to expect too much. "We are passing," said Mr. Bellamy, in his peroration, "through trying and troublous times. Labour is become articulate; the unrest which has been a feature of the industrial world still continues; we are assuredly on the eve of great changes, and it is for railwaymen, who have now evolved one of the greatest trade unions that has ever existed, and who are as a rule far from revolutionary, to see that the great organisation makes good and that it becomes a powerful lever for uplifting and emancipation." "Uplifting" and "emancipation" are dangerous words, words of fire. They bring to the mind degradation and slavery, and many a man who has been happy and contented enough before, kicks and struggles if he is led to believe that he is being put upon and enslaved. Those words almost undo all the temperate observations that had preceded them, and make even Mr. Bellamy's softest phrases read like threats. Mr. Bellamy may, after all, be only another Lambro, the "mildest mannered man that ever scuttled ship or cut a throat." We do not write this in any alarmist spirit; the triple alliance may see reason when it comes to the point; but we do wish to warn the public against being coaxed into a fool's paradise, against being persuaded that because of its strength this new power is likely to be more tolerant and more amenable than when several units took up several separate cudgels. There is no sound foundation for that belief. Strength must be met with strength, self-reliance with self-reliance, determination with determination. The railways are to be attacked in the autumn or the spring; they must be able to present a united front to the unions; they must have a single policy, and they must adhere to it resolutely. Any weakness or irresolution, any division of force, must infallibly weaken them, not only before the attacks of the triple alliance, but in the face of the public, which, after all is said and done, will be the final arbiter.

Of other subjects which were discussed at the conference we propose to say but little. The eight hours' day and the five-shilling rise all round is a programme sufficiently disturbing to stand alone. Nationalisation came, of course, before the conference, but we await with equanimity the findings of the Royal Commission on that subject. It is, at any rate, a thing which even the triple alliance would be powerless to force upon the country if the people were opposed to it. When nationalisation comes—if it ever does come—it will not be at the dictation of trades unions, but at the will of the whole country. For ourselves we believe that it is further off than ever. Much talk there will be about it, but not for long will it become so present and so menacing a subject as the railwaymen's programme.

### The Paris Metropolitan Catastrophe.

FOLLOWING upon one of the most violent storms that have been experienced in Paris for many years, the tunnel under construction for the new Metropolitan line between the Rue Taitbout and the Trocadéro collapsed on June 15th at three points—Boulevard Haussmann, Place Saint Augustin, and Place Saint Philippe du Roule—engulfing a taxicab and at least twelve persons, who were buried under the *débris* or drowned by the flooding of the tunnel. This catastrophe proved the culmination of a series of smaller accidents of a similar character which had already given rise to serious uneasiness, and since then the route followed by the new line has continued to sink in places, and has even opened out in fresh holes.

To explain the causes of this collapse it is necessary to describe the conditions under which the Metropolitan is constructed. The soil upon which Paris is built has a deep substratum of sand, formerly covered by the Seine, which in times past skirted the hill of Montmartre. In course of centuries this stratum was covered with all sorts of material, offering a friable deposit of varying thickness with exceedingly hard rocky masses, generally of small volume, which made the employment of the Berlier shield impossible when it was tried on the first line constructed. Owing to the presence of subterranean water the tunnels are, for the most part, constructed near the road surface. In driving the tunnel the earth is first removed at the roof, which is timbered and then finished with concrete. The excavation is then continued downwards. The tunnel between the Rue Taitbout and the Trocadéro is at present in this condition. Seeing that the Paris subsoil is already burrowed with mains for sewage, water, gas, compressed air, telephones, and electricity, it is obvious that a tunnel cannot be driven without displacing some of these mains, often at great trouble and cost, and there is consequently a disturbance and loosening of the soil on one side or other of the tunnel. When a main is displaced the earth underneath packs and sinks, and the main is left practically suspended in places until the work of tunnel construction is completed. The explanation of the catastrophe is therefore simple. The mains could not withstand the exceptional pressure put upon them during the storm, and they collapsed at the weakest points—that is to say, where they were suspended, and the water washed away the earth supporting the concrete roof of the tunnel, which fell in. Whether there are any accessory causes contributing to the accident it is difficult for the moment to discuss. This will no doubt be fully dealt with in the official report. As was to be expected during a time of public excitement, all sorts of charges have been brought against the engineers and contractors, and an inquiry has been instituted by the Minister of Public Works with a view of fixing responsibilities and taking the necessary measures to prevent similar catastrophes in the future. It is to be deplored that capital is being made out of this accident by the Syndicalists, who affirm that the work in the Place Saint Augustin was carried out by men belonging to the "Free Union." An inquiry seems to show that this was not the case. The Syndicalists also attribute the accidents to the speed at which the tunnel was driven. They object to rapid work on principle, and this deplorable example of the sad effects of

working fast is too good to be lost. Again, the Syndicalists affirm that the concrete employed for the tunnel is often of bad quality; the proportion of cement to sand is too small, and the sand used is riddled from the soil extracted. It is possible that this charge may have some foundation in fact, since it is certain that the tunnels reveal occasional defects, and only a little while ago there was a partial collapse on the line between the Opéra and Auteuil. The tunnels are, moreover, anything but water-tight. Nevertheless, these defects only develop on the new lines; on the others, which have been in service for years, there does not seem to be any evidence of structural weakness.

The alarm created by the collapse has given rise to a feeling in some quarters that it may be desirable to suppress the additional lines which it is proposed to construct. Seeing that in some places the wood pavement is laid almost directly on the roof of the tunnel, it is feared that the increasingly heavy traffic, particularly with the huge motor omnibuses, may eventually result in still more serious accidents. Besides the Metropolitan tunnels, there are the mains, some of them of considerable diameter, and a section through a road presents so many openings that Paris seems to be built upon a gigantic mole hill. This, however, is not in itself a source of instability on condition that the soil is suitably packed, as necessarily happens when the whole work of construction is completed. The trouble only arises when the subsoil is disturbed during the operation of tunnelling, and it is evident that the recent catastrophe, as well as the many warnings given from time to time by street subsidences, show the necessity of taking the greatest possible precaution and exercising a strict supervision over the quality of the material employed in the construction of the tunnels. The catastrophe will not stop the extension of the Metropolitan system. It has become a necessity, and it is inconceivable that Parisians should be deprived of this means of locomotion. The catastrophe is one of several that have marked the history of the Paris Metropolitan.

### The Cultivation of the Chinese and South American Markets.

THE contest for the purpose of securing a larger measure of the growing trade of China and of South America promises to be exceedingly keen in the future in consequence of the increased interest which is being manifested with regard to these countries by industrial circles in Great Britain, the United States, and Germany. It may therefore be appropriate to discuss the subject on the present occasion, especially as the manufacturing concerns which cover numerous industries in the United States have just awakened to the necessity for the further promotion of their export trade in general. In one respect—namely, in the direction of the establishment of engineering schools in China—the Germans have followed the example of British firms. The English University at Hong-Kong and the technical school projected at Yangshan, for instance, are now being emulated to some extent by the erection of a German technical school at Shanghai for instruction in the German language and engineering. The internal equipment of this school was nearly completed at the beginning of the present month, and the two language classes and the three engineering classes will provide instruction for a total of 102 students. A site for the erection at Hankau of a second engineering school has been acquired, and the foundations are being laid. At the same time suggestions have been made in favour of the institution of similar schools in South America, particularly in Brazil, in the expectation that students in these foreign schools will become imbued with German ideas and German technical terms and journals, and ultimately become, as far as concerns the special branch of engineering to which they may be appointed at a later period, lasting customers for Teutonic engineering manufactures. On the other hand, the industrial circles in the United States have so far not experienced any necessity for proceeding in a similar manner either in China or South America, and as their language is identical with that of Great Britain it will be possible for them to dispense with the foreign school question and to rely upon their characteristic hustling methods, combined with direct representation on the spot by qualified engineers, after the pioneer work has been accomplished by British firms. It must not be forgotten, however, that they recognise the influence that a school may have on trade, and that a great effort was made to get the engineering laboratories at Hong-Kong equipped wholly with American plant. This effort was luckily circumvented by the energetic action of Professor C. A. M. Smith and the British Engineers' Association.

The latest development in the United States, which contemplates the beginning of a new era in the advancement of the foreign trade of that country, is largely an indirect result of the tariff revision which took place in 1913, and which, owing to a number of commodities having been placed on a free list and the import duties being reduced on many others, is declared to have opened up the prospect of a great extension in the interchange of trade with Canada, Argentina, and other countries. This assumption led to the assembly at Washington at the commencement of June of one of the most remarkable and important commercial conferences ever held in the United States, over five hundred representatives of trade and industry being present, and the proceedings extending over several days. Apart from possible trade developments with China and Japan, the principal centre of interest was concentrated in expansion of business with Central and South America. For the present, however, we are only concerned with the final result of the conference, which assumed the form of the constitution of a National Foreign Trade Council and the adoption of resolutions which, having been endorsed by the representatives of the Government who were present and having been favourably received by the newspapers, are expected to be realised in substance in the near future. In the first place, the Government is asked to establish a special export bureau and to allot to it the sum of £50,000 per annum, and to make provision for the appointment of further commercial *attachés* and commercial agents abroad. The second point to command attention, of which something was heard a few months ago, is the expression of the wish that Congress should so amend the Anti-Trust Law that nothing should be allowed to stand in the way of the formation of combinations of American firms for the promotion of the export trade alone. In addition, the Government is requested to pursue a more active policy in the conclusion of reciprocity treaties of commerce, to undertake a comprehensive industrial census in connection with the next national population census, to grant larger sums for the Consular service, and appoint more highly qualified Consuls, and to take steps in the direction of the creation of an American merchant marine, without, however, granting any subsidies. If it is possible for these proposals to be carried through Congress and the Senate, a great step in advance will be made in the cultivation of the export trade, which is at present assisted by an excellent Consular service, but which has been already largely developed by private initiative in the form of huge combinations, as in the case of iron and steel, agricultural machinery and machine tools, in the course of the past few years. These branches have also been materially aided by the establishment of foreign departments or works and the maintenance of show-rooms in other countries, together with, in some instances, a staff for the purpose of undertaking repairs, as in Australia and Argentina or Brazil.

If we now revert to the trade question in the Far East it is found, according to figures placed before the recent conference at Washington, that the first position in Japan is occupied by the United States, which absorb 32 per cent. of the total value of the Japanese exports, whilst the United States purchase 20½ per cent. of the exports from Japan. The commercial relations of America and China, however, have not developed so favourably, although the president of a China and Japan trading company expresses very sanguine views as to the future course of trade with that country. There is, however, as previously mentioned, no question of American technical schools in China. Apart from other points already set forth, the Americans as well as other nations are quite aware that English is to a large extent the second official language in China, and that English is the second language preferentially learned and spoken by Japanese engineers. It is therefore unnecessary for the Americans to trouble themselves about schools, they being content with direct representation with, if possible, engineers who can become gradually acquainted with the difficult Chinese language. On the other hand, it is advisable to note that, although they have followed the example of Great Britain or of the British Engineers' Association, the Germans recognise that the establishment of engineering schools in China cannot replace more direct methods of securing the market. This will be obvious from the address which was recently delivered by Professor Wiese, of Düsseldorf, before the Verein deutscher Eisenhuttenleute on "The Economic Problems of the Far East." The speaker, whose observations were received with approval by the members of this iron and steel institute, stated that schools are only one of many means for the advancement of the Teutonic export trade. In his opinion it is more important to secure greater uniformity in the action of different circles, especially of official and merchant circles; a more rational regulation of the Chinese import trade is necessary, so that German industrial firms, their foreign representatives, and the import firms in China, together with the Consulates, should co-operate instead of working against one another; it is essential for the German official representatives, especially the embassy in Pekin, to keep in constant touch with the Chinese and Chinese-speaking foreigners; the aim in view can best be accomplished by those who devote themselves to Chinese affairs permanently on the spot; and, finally, a more active policy in railway and loan questions is deemed to be indispensably necessary. The respective cases of the commercial interests of the United States and Germany, as set forth, are of particular interest to British firms. As presented they point their own moral and leave no opening for further comment on our part on the present occasion.

### Port and Starboard.

A COMMUNICATION has been sent to the Mercantile Marine Service Association and to the Imperial Merchant Service Guild respectively by the Board of Trade inviting their opinion upon a recommendation made at the last International Conference on Safety of Life at Sea that some international agreement should be come to with regard to the form of the orders which should be given to a steersman or quartermaster by a captain or pilot who is responsible for navigation of a ship. Under the British flag the order "port a little" or "hard a port" means, of course, that the captain requires that the rudder shall be swung over to the starboard side of the ship; this has the effect of turning the bow toward the right, so that really the order "port" means "turn the ship toward starboard." It is easily understandable that seamen of other nationalities than ours look upon the order and its effect as opposed and confusing. The genesis of this practice of the British marine is interesting, and more natural than it appears at first sight; but whilst we use the terms "port" and "starboard" to designate the left and right sides of a ship respectively, when the observer is facing towards the bow, some nationalities actually use the simple terms left and right in place of port and starboard, and there is much to be said for the direct application of these well-recognised terms. Our anomalous procedure has, of course, arisen from the fact that when a straight tiller or helm attached directly to the rudder was used it had to be pushed over to port in order to move the rudder to starboard and *vice versâ*, but with the introduction of mechanical wheel steering the visible helm disappeared from the scene, yet the form of command remained. Like many other things of the kind, the genesis of the practice is clear, but under the conditions of modern navigation its retention is not easily defensible, and it is not surprising that seamen of other nationalities who have cut themselves free from hereditary trammels, or perhaps never had them to begin with, should desire that a uniform system be adopted, and presumably that it should not be the one favoured, or at least practised, by us. It must, indeed, be a source of possible error on many occasions when sailors change from ships where one method is in use to another in which the directly opposite practice obtains, and it might be the cause of serious accident or even disaster if such a mistake happened at a sudden pinch, when excitement and haste relax a man's guard. It is not clear that foreign countries are all agreed as to the exact form that an international practice shall take, but it seems that they are almost unanimously agreed that the British system is unsuitable for modern conditions. What is to be done? The change, simple as it seems, is by no means easy to make, and the British delegates to the Conference felt that the matter was one demanding the most serious attention and consideration. If it were done there would undoubtedly be a transition period during which many mistakes would be made, especially if the terms port and starboard were adhered to. It would be extremely difficult to remember automatically that the order "port" meant the opposite of that which it has meant to a man all through his lifetime, and that the ship's head must go to port, but it is not impossible to do. It would perhaps make the matter easier of accomplishment if a complete change of term were introduced, such as, say, "right" and "left," which, as we have shown, are sometimes so used; these would have the same meaning as the same terms in military drill, "right turn" meaning turn towards the right when advancing, and "left" the opposite. Nothing could be simpler than this, and the terms "right" and "left" side of a ship would always refer to the position of an observer on the ship facing the bow just as the right or left bank of a river always refers to its direction of flow to the sea. The suggested change may seem a small one to many, but not to those who know how deep such a simple practice goes. The delegates stated clearly their opinion that a sudden change of the kind would involve certain risk of confusion and danger, and

should only be introduced after most searching consideration of the matter in all its bearings by shipowners, shipmasters, and officers. It will be interesting to know what the replies to the Board of Trade are, for our system is undeniably contradictory in its terms, and a uniform practice is much to be desired, yet it may be difficult to convince many that the apparently simple change can be easily effected. The question has arisen, naturally, from the recent Conference, and it is an entirely suitable opportunity to settle it one way or another.

## INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

### No. II.*

THE discussion on Mr. Fedden's paper, abstracted in our last issue, was a long and valuable one.

Mr. W. W. Lackie, chief electrical engineer to the Glasgow Corporation, said he had proved recently in Glasgow that nothing but steel should be used in steam pipe lines. On one occasion a crown head valve of a boiler burst whilst the boiler was in commission, and if another valve had not been in series with the faulty one, and in such a position that the steam from the main range could be cut off, serious consequences would have resulted. The Board of Trade inspector made a thorough investigation into the possible causes of the mishap, and it was quite clear in his conclusion that the trouble had been entirely due to superheat, and that steel was the only adequate safeguard against the recurrence of such an accident. Coal measuring chambers had been found by him to be quite unreliable, and he used nothing but automatic weighing machines, one to each boiler. The last coal strike demonstrated the necessity for having a large store of coal. In his opinion, the stock of coal on hand should always be not less than the equivalent of a two months' supply, and he believed it would pay to have even a larger supply than this. The storage accommodation should be such that instead of taking in a larger quantity of coal in the winter months and a comparatively small quantity in the summer months, uniform deliveries should be taken all the year through, and, if anything, a larger supply during the summer months. The wear and tear of bucket conveyors for the removal of ashes was so great that these conveyors were being abandoned. Recently, he had installed a suction ash plant, which had been in operation with most satisfactory results for six months. The cost of operating the suction ash plant worked out at about 5 units per ton. This might seem a large figure, but against it must be set the reduced cost of maintenance on moving plant and better conditions for the men. He noticed that Mr. Fedden recommended a combustion rate of 25 lb. per square foot of grate area. It might be interesting to quote a test he made recently in one of their stations. He took four hand-fired boilers dealing with a 5000 horse-power turbine, and burned coal at 30½ lb. per square foot, and generated 21,600 units, the pounds of coal per unit being 3.41. He put on another boiler, making five, and reduced the coal burned to 21 lb., and the pounds of coal per unit were 3.23, a reduction of 5½ per cent., the draught in both tests being 0.4 water gauge. In his opinion, however, it was not justifiable to work at these rates. One of the objects of his recent visit to America was to see how they tackled emergency peak loads or sudden demands due to fog or black clouds, more especially in Chicago and New York. He was shown the Taylor stoker, which had been fully tested, and responded to sudden demands in a most remarkable manner. He was so much impressed with it that on his return he got the Electricity Committee of Glasgow to agree to equip two boilers with it. The stokers are put under boilers, which normally evaporated 24,000 lb. of water per hour, and the guarantee for flexibility which the manufacturers of the stoker had given was that when the fuel bed of the stoker was maintained in a live banked condition, an interval of not more than ten minutes would be required to bring the boiler up to the rate of steaming corresponding to an evaporation of 24,000 lb., and not more than an additional five minutes to bring the boiler up to a steaming capacity of 46,000 lb. The combined efficiency at 24,000 lb. was guaranteed at 72 per cent., and the stoker should be capable of burning sufficient coal to evaporate a maximum of 58,000 lb. of water. It was not their intention to run the boilers at these high rates for any length of time, but only to give sufficient time to get other boilers under way. Also as the result of his American visit he had installed a steam meter made by the General Electric Company of America. It was fixed on a boiler tested recently at Glasgow, and the indications were so satisfactory when compared with the measured water in the tanks that they were now equipping each boiler with a steam meter, in the same manner as an ammeter is connected to a generator.

Mr. J. W. Beauchamp, chief electrical engineer to the West Ham Corporation, referred to the cost of the removal of ashes and dust. He had a suction ash plant, which had not been working for a sufficient length of time to obtain any precise costs, but, as far as he could see, they were going to be of the following order. The capital charges for the removal of 10,000 tons of ashes per annum from the ash tunnel to the slip where they were transported by barge or cart would come out to 7d. per ton, and the electrical energy 2d. That 7d., however, would become 3½d. if the quantity of ashes were doubled, as the plant had an immense capacity for future development. His plant was of the pattern with a Roots exhauster, and no difficulty had been found with regard to repairs or erosion of pipes except at bends, but there it was easy and cheap to replace them. The only difficulty found so far was with regard to the emission of dust, which depended upon the quality of coal used. This difficulty, however, was being dealt with by the makers, who were putting in a separator, which had the effect of keeping the dust back. It might also be dealt with by the use of wet screens as used for cleaning the air of buildings. With regard to the general arrangement of boilers, both the author and Mr. Lackie had made reference to the erection of the economisers above the boilers. That was being done a great deal, and it lent itself very well to the separation of the boiler-house and a saving in floor space, but there were one or two minor disadvantages, but not sufficient to affect a big station. For instance, with the economisers above the boilers, it was difficult to keep them full of water when the boiler was standing. There was a tendency for the level to drop, and the upper part of the economiser to become full of air; therefore there was a delay when starting the feed pumps before water appeared in the boiler. Moreover, it seemed reasonable to anticipate that corrosion would take place in the economiser at the air and water level, and it would probably be found necessary to make special arrangements to keep the economiser plumb full of water when the boilers were standing. With regard to the general design of power stations, there was one point which the author had not touched upon, and which had not received the attention it probably would in future designs for very large power stations, and that was the provision of air required for the consumption of fuel in the furnaces. This, in large stations, was of enormous volume, and whether natural or suction draught were used, this air was generally obtained from all sources, *i.e.*, through doors, windows and other openings, and during the winter weather, when there was a tendency to restrict openings to the outer air, very acute draughts might be produced. He believed some work had been done in the direction of leading the heated air from the engine-room into the boiler for this purpose, and it seemed to be a scientific and natural method tending to keep the engine-room cool and to provide the boiler furnaces with air which had already been raised to a fair temperature in the process of cooling generators. Unless attention was given to this point in the original design, it would often be found that basements, pipe openings, &c., would render any systematic method impossible.

Mr. C. H. Wordingham, chief electrical engineer to the Admiralty, referring to the use of special trucks at Sheffield, said he was surprised that more use had not been made of the "tippler," by which the coal was allowed to fall out of the truck without any hand labour. It got over the difficulty of having special trucks, and avoided the danger of damaging the railway companies' rolling stock. Mr. Fedden used a mixture of steam and electrically driven boiler feed pumps, and it would be interesting to know upon what grounds he used both types. With regard to gas-fired boilers, there was obviously, in view of the large generating units now employed, an impossibility with our present knowledge of using large gas engines. He thought, however, that the position might be altered, and altered materially, by the new system of surface combustion, in which, instead of applying the gas to the engine, it was applied to the boiler, thus giving greatly increased efficiency, and a very large reduction in the size of the boiler.

Mr. W. C. P. Tapper, chief electrical engineer to the Stepney Borough Council, said he had put a live steam feed heater into the hot well, and discharged the steam from the reciprocating pumps through the heater, thus retaining all the heat and discharging the oily contents of the water into the drain. He was now putting in a turbine-driven rotary feed pump, and the whole of the exhaust from this would be turned back into the hot well. At Stepney he was the first to install the Prat system of induced draught, having put in four chimneys dealing with eight boilers. In that case the chimneys worked on what was called the cold-blast system, and they had worked entirely satisfactorily. In the extensions at Stepney he was putting in the later type of Prat chimney with the in-circuit system, *i.e.*, a fan draws a certain proportion of the boiler gases and passes them back under pressure into the chimney. The general arrangement would be a boiler with a travelling grate stoker and forced draught under the stoker and induced draught above it, thus giving a balanced draught on the bars, each boiler complete with its own chimney.

Mr. G. D. Seaton, of Richardsons, Westgarth and Co., Limited, referred to the question of guarantees of output of electrical machinery. Those, he said, who within the last year had been calling for tenders for steam engines knew they had been offered some exceedingly fine steam consumptions, and at the last annual convention he had the opportunity of pointing out how these very fine steam consumptions were obtained when purchasers were foolish enough to give makers the opportunity. His remarks caused great discontent in certain quarters, as he had every intention that they should. He was now able to tell one little sequel of last year's convention. Some time ago he lost a substantial order for turbine plant owing to competitors guaranteeing a pound per kilowatt less than he did, and when he said better than he could possibly do, it meant better than Brown Boveri, with their many years of experience behind them, knew was possible. It was, however, very soon found out in the boiler-house that something was wrong when the plant got to work. Many engineers objected to calling in an independent man, but he would like to put it to the chairman and conveners that it was their duty to see that these plants were properly tested.

Mr. R. U. Bailey, resident engineer at the Summer-lane power station, Birmingham, speaking as an operating engineer, said he did not think that steam auxiliaries were employed to the extent they deserved. With electrically driven auxiliaries, in the event of an interruption to the supply, the motors at once failed, and this, of course, greatly complicated the restoration of supply, and in many cases endangered the plant, and in any case considerably increased the period in which the station had to get under way again. On the other hand, the small steam plant was less liable to break down than motors where continuous running was necessary. It was stated in the paper that when burning 25 lb. of rough engine slack per square foot of grate area, 5.25 lb. of water would be evaporated per square foot of heating surface. This amount of coal per square foot of grate area was exceedingly low when obtaining such high evaporation. In general practice he thought 32 lb. per square foot was more likely to be obtained when working a water-tube boiler at its rated normal capacity. The figure of 5.25 lb. of water evaporated per square foot of heating surface was exceptionally high, as, in applying this duty to a standard 24,000 lb. per hour Babcock boiler for comparative purposes, the duty would be 32,455 lb. per hour from and at 212 deg. Fah., which was 35.5 per cent. over duty. He therefore did not think that these figures were consistent with conditions obtained in common practice. A further set of figures was given relating to a duty obtained with the Underfeed stoker, and it was intensely interesting to find that the boiler duty could be increased 65 per cent. above normal. With reference to the remarks on stokers, Mr. Fedden enumerated the difficulties which existed with chain grate stokers, and undoubtedly when burning a fine slack the handling of the riddlings made was a matter which had to be taken seriously into consideration, as the amount was between 3 and 4 per cent. of the total coal passed over the stoker. These riddlings had a very much reduced calorific value as compared with the main fuel, due to the volatile matter being very small indeed. The riddlings, however, had a high carbon value. The general practice was, he believed, to throw these riddlings periodically again into the hoppers, but this had the effect of spoiling the fires and upsetting uniform combustion. At Summer-lane station two Underfeed stokers were employed almost entirely burning these riddlings, and it was found that this method was highly economical. It would, of course, be impossible to use a chain grate stoker entirely for this class of fuel, as having practically no volatile value there would be little or no flame; consequently, the temperature of the arches would be below that necessary for igniting the fuel. Mr. Fedden touched upon the all-important question of coal storage, and drew attention to the fact that screened nuts were the class of fuel which could be stored in comparative safety, but he thought Mr. Fedden had omitted to state the most important point of all in this connection, viz., that in the satisfactory storage of coal there must be entire absence of sulphur. It was undoubtedly the presence of sulphur in coal which was at the root of the evil of spontaneous combustion, the sulphur, which was usually present in the form of iron pyrites, readily disintegrating, thereby causing heat to be generated. If coals which were free from sulphur were stacked, he thought that they could be treated with a certain amount of latitude. At Birmingham they were at present carrying a stock of 10,000 tons, the largest heap being 4000 tons. This coal stock was made up of 3in. nuts at the base, and graded through the various sizes of nuts to shallow screenings at the top. The depth of the stack was 12ft. The object of this grading was to allow any local heat which might be generated to be readily dispersed through the interstices of the coal. The chance of firing was, of course, greater at the base, due to the weight of the coal above. A smaller heap made in this way, containing 1500 tons, had been down for about three years, and they had up to the present been unable to detect any appreciable rise in temperature above that of the atmosphere. They also had a smaller stack of 700 tons, which had been standing for about six years, the heap consisting entirely of nutty screenings, and to-day practically showed as high a calorific value as when put down, the crust only being weathered. This latter stack was put down at the same time as other stacks of coal drawn from other collieries, which readily gave trouble owing to spontaneous combustion, and they had since found by analyses that the coal standing to-day was the only coal free from sulphur, and it was on this finding that they had ventured to put down stacks of the size and depth he had just described.

Mr. W. R. Wood, of the Underfeed Stoker Company, gave the results of some tests, in which the evaporation was 8¾ lb. per square foot of heating surface; the escaping gases in the boiler had a temperature of 530 deg., and the escaping gases in the economisers had a temperature of 310 deg., whilst the efficiency was approximately 85 per cent. From this, he maintained, it could be argued that high rates of combustion under proper conditions did not reduce the efficiency of a boiler plant.

Mr. J. K. Brydges, chief electrical engineer to the Eastbourne Corporation, referred to the use of live steam heaters at Sheffield, and suggested that the exhaust from the feed pumps, which was also put into the hot-well, contained sufficient heat to heat this water in the feed well up to a safe temperature to be put into the economisers, so that the economiser tubes would not be damaged. This would give as high a heat in the feed water as could be obtained in any other way, and there would be no necessity for the live steam feed heaters. With regard to mechanical stokers, he believed there was an apparatus for pre-heating the air before it got into the boilers. If it were necessary to raise the temperature of the air after it got into the boilers for combustion, why not raise it before? He believed these pre-heaters had been used, and he would like to hear experiences with them, and what they saved in £ s. d. It had been suggested that the pre-heating of the air caused excessive burning of the grate bars, on account of there being less cooling effect, as compared with putting in cold air, and that it also necessarily meant there must be a closed ashpit or loss of air carried to the grate. He was rather surprised that Mr. Fedden had not referred to air heating in his summary of the most economical types of different parts of plant to put in. Similarly, he would like information with regard to induced draught plant, as to whether the Prat system or the forced draught or any other type of cold draught was the best. With regard to coal storage, it might be interesting to know that he found it absolutely impossible to store slack coal in heaps of more than about 8ft. deep, although his bunkers were 21ft. deep. He now used pea coal, and, oddly enough, it contained sulphur, but in spite of what Mr. Bailey had said, he could stack this coal 18ft. deep. He had fitted tubes, through which he could drop thermometers, and had not found the rise of temperature to be more than 10 deg. to 12 deg., and when it got to that figure it seemed to stay at it. With regard to evaporation per square foot of heating surface, he agreed with the previous speaker that 25 lb. per square foot was plenty. A higher rate might do with a vertical tube boiler, but he did not think the same evaporation per square foot of heating surface could be got out of a Babcock and Wilcox as out of a vertical tube boiler.

Mr. F. Ayton, chief electrical engineer to the Ipswich Corporation, speaking with regard to draught, said he had kept the records of the variation of the draught in his boiler-house with the wind in different directions, and the different strengths of wind, and curious results had been obtained. This suggested to him that in designing a new boiler-house it would be an advantage to arrange the openings on the four cardinal sides of the boiler-

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house, so as to get the maximum effect by opening them on the side where the wind was blowing. As to storing coal, he used Nottinghamshire slack, stored in heaps not less than 12ft. deep, and had never had any trouble with firing. The coal, however, was not strong in sulphur content. He asked for information as to the life of the links of chain grate stokers. He was always having trouble with these. He used the Babcock and Wilcox type, in which each link had a small projection, and had found these ends burned off in a very short time.

Mr. S. Utting, referring to the Prat system of induced draught, said there were many systems masquerading as induced draught, forced draught or similar systems, which were very different to the Prat system, and he did not see why a system which was the result of nineteen or twenty years' practical working should not now be known by its name in just the same way as, for instance, the Corliss engine was known. If the matter were investigated, it would be found that the Prat system was the only one entitled to the name "induced." Mr. Tapper was the first central station engineer in this country who had experience of the Prat system, by which cold air was injected into the chimney in order to induce the flow of the main current. He had spoken to many engineers, and they seemed to imagine that the Prat system consisted of having a chimney and cold air injection, but nine or ten years ago Prat developed another means, whereby he used the main flow of the gases in order to create this induction. Such a plant had actually been designed for Birmingham, and had been working for some time.

Alderman H. Gervis, of Brighton, commented on the necessity for the employment of highly trained technical men, but it was the most difficult thing to do to convince a Council of this—at least, it was so in the South of England. A great deal was heard as to the work that was done by the working-men, and the production which was brought about by their work, but nothing was heard of the brains that made that production possible.

Mr. S. Z. de Ferranti, speaking first with regard to air heating for boiler fires, said that theoretically it was perfectly right to heat the air for combustion under the boiler, but in practice little satisfaction had been obtained from this process. He had kept in touch with this matter for a fair number of years, both in seeing what others had done and in experimenting himself, and the real trouble was that the apparatus, which in itself was very simple, was not at all efficient. In the first place, the plant was invariably put in too small, and the result was that instead of the air being properly heated up to a fair equivalent of the temperature in the out-going gases, a very poor result was obtained. That was the first part of the practical failure. He knew of particular installations, not so much in electricity works, but in factories in this country, where the system had been used, but no special results had been got from it, and no further installations had been put in. An investigation of the causes showed that with only a moderate efficiency from the plant there had been very great trouble with fire-bars, which, with hand stoking, had stood, but with various forms of mechanical stokers there had been nothing but trouble. It must not, however, be imagined that that would always occur, or that he wished to put engineers in doubt as to the development of this apparatus. All he warned them to do was to take nothing for granted, and to be as sure as they could that they were going to make a real saving, and that the money spent would be well spent.

Mr. W. M. Selvey, of Sheffield, warned central station engineers that the question of buying coal was one to which more serious consideration would have to be given in the future. Nobody in the discussion had taken up the question of the relation of coal to the furnace which it was burned in, and in this connection he recommended them to study the experience of the Navy people and the locomotive people, who had had a very much harder problem than central station engineers. It would be necessary more and more in the future to keep boilers at right angles to the engine-room. It would be necessary to make these boilers even bigger. It would be necessary absolutely to put the economiser on top of the boiler, and it would be necessary to make the economiser fill the whole of the available space that there was on the ground plan of the boiler. Even with this they would have serious difficulties in keeping the boiler-house alongside with 20,000 kilowatt units. The question of the boiler-house in this respect was entirely one of the stoker. Think what they had done. In the engine-room they had a machine which would give from 100 per cent. overload to quite a light load, and give a satisfactory output all the time; they had turbines which could be governed to any degree of nicety for any practical requirements in the variation of speed. But what had they done in the boiler-house. The size of boilers had not increased; in other words, they had rested by the way, and now that it was time to move it was found necessary to go to America for stokers. He did not think this was necessary, and although the Taylor stoker was quite good, it was only a passing phase. It was only necessary to go to the rock bottom to see what was wanted. Two things were wanted. First, a perforated platform to support the coal; and, secondly, a means of driving this platform. Developments in this direction had already been made, particularly in the direction of separating the function of the platform from the function of the driver, which tended to make the arrangement flexible in the same way as the governor made a turbine flexible.

Mr. S. E. Fedden was unable to reply to the discussion owing to lack of time.

The meeting on Thursday, June 18th, was held in Stratford-upon-Avon, and the whole morning was devoted to a long and detailed paper on the standardisation of tariffs by Mr. J. H. Bowden, chief electrical engineer to the Poplar Borough Council, which was followed by an equally long and detailed discussion.

The paper practically divided itself into arguments for and against two systems, namely, the rateable value system, under which a consumer's bill for electric lighting is based upon the rateable value of his house, and the other system, under which the consumer pays a fixed charge per annum per kilowatt of demand, plus a small charge per unit for all energy consumed. Mr. Bowden is an out-and-out opponent of the rateable value system; but, on the whole, opinions were fairly equally divided as between the two. The object every central station engineer is aiming at, however, is to gain an entry into the working-class house, and this in the past has given rise to a good deal of experimenting with apparatus in various parts of the country. This still remains a very important factor, but another equally, if not more important, aspect of the tariff question is the obvious outlet there is for the supply of electricity for heating and cooking purposes. Under both the tariffs mentioned above, the whole of the requirements in the way of lighting, heating and cooking would be dealt with by the one tariff, without the complication which now exists in many places of having separate meters and often separate wiring, as between the lighting and the heating and cooking apparatus. Although Mr. Bowden's paper was entitled "The Standardisation of Tariffs," there was a strong feeling that this is impossible, and, indeed, impracticable. At present quite a considerable number of methods of charging are in use in various parts of the country, and each exponent of the various methods claims to have achieved—and, indeed, has achieved in many instances—quite remarkable results, in face of the keenest competition with gas. The net result of the paper and discussion might be summed up that each district must really be dealt with on its own merits, according to the particular local circumstances, and a suitable tariff arranged accordingly. Clearly, however, the interests of manufacturers are bound up with this question of tariffs, as even under the present more or less unsatisfactory condition of affairs *qua* heating and cooking, complaints are coming in as to the inability to obtain cooking and heating apparatus quickly enough. Manufacturers seem to be putting these through the shops in dozens instead of hundreds, but once a satisfactory tariff is hit upon, or, as has been suggested, a large number of station engineers take up one particular type, these complaints would naturally cease, as also would the price come down—as it must do—very rapidly.

At the annual general meeting on Friday, June 19th, Mr. H. Richardson, chief electrical engineer to the Dundee Corporation, was elected President for the ensuing year.

A resolution was passed authorising the Council of the Association to create a committee whose function is to be the development of all possible uses of electrical energy. This may be taken as intended to replace to some extent the defunct Industrial Committee of the Institution of Electrical Engineers, in connection with which some very outspoken remarks were made, and the intention is to completely sectionalise this new committee so as to deal with all branches of the industry. Moreover, the committee will have power to co-opt any outside association or person who might be of assistance in the work to be undertaken, and it is not inconceivable that the existing Electric Vehicles Committee of the Association and the "Point Fives" Association, which is dealing with the heating and cooking question, will become affiliated in some form.

## BOOKS RECEIVED.

*Waterworks Engineering.* By Fred. C. Uren. Bristol: Castle Litho, Limited. No price stated.

*Gearing.* By A. E. Ingham. London: Methuen and Co., Limited, 36, Essex-street, Strand, W.C. Price 5s. net.

*The Making of Highroads.* By Alfred Edward Carey. London: Crosby Lockwood and Son. Price 2s. 6d. net.

*The War Traders.* By G. H. Perris. London: The National Peace Council, 167, St. Stephen's House, S.W. Price 1s. net.

*Complex Integration and Cauchy's Theorem.* By G. N. Watson. Cambridge: At the University Press. Price 3s. net.

*The Mechanical Design and Construction of Generators.* By R. Livingstone. London: *The Electrician*, Salisbury-court, E.C. Price 9s. net.

*Practical Well Sinking.* By B. A. Harrison. London: The Technical Publishing Company, Limited, 55–56, Chancery-lane. 1s. 6d. net.

*Hydraulics.* By W. M. Wallace. London: The Technical Publishing Company, Limited, 55–6, Chancery-lane, W.C. Price 4s. net.

*The Social Guide*, 1914. Edited by Mrs. Hugh Adams and Edith A. Browne. London: Adam and Charles Black, Soho-square, W. Price 2s. 6d. net.

*Molecular Physics.* By J. A. Crowther. Reprinted from the *Chemical World*. London: J. and A. Churchill, 7, Great Marlborough-street. Price 3s. 6d. net.

*The Dock and Harbour Engineer's Reference Book.* By Bryson Cunningham. London: Chas. Griffin and Co., Limited, Exeter-street, Strand. Price 7s. 6d. net.

*The Rating of Machinery: Some Facts and Fallacies.* By G. Humphreys-Davies. London: The Manufacturers' Association, Limited, 110, Cannon-street. Price 2s. net.

*Influence Diagrams for the Determination of Maximum Moments in Trusses and Beams.* By Malverd A. Howe. London: Chapman and Hall, Limited. Price 5s. 6d. net.

*A Practical Treatise on Subaqueous Foundations, including the Cofferdam Process for Piers and Dredges and Dredging.* By Charles Evan Fowler. Third edition. London: Chapman and Hall, Limited. Price 31s. 6d. net.

THE AERONAUTICAL SOCIETY.—The Council of the Aeronautical Society of Great Britain announces that it has awarded the gold medal of the Society to Professor G. H. Bryan, F.R.S., for the great services he has rendered to aeronautics by his development of the theory of the stability of aeroplanes. Professor Bryan is an old member of the Society, to which in 1903 he communicated, in conjunction with Mr. Ellis Williams, a paper on "The Longitudinal Stability of Aeroplane Gliders," which contained the beginnings of the theory of stability he has since developed and published in his book "Stability in Aviation." The previous recipients of the gold medal of the Society, which is the highest award of British scientific aeronautics, are Wilbur and Orville Wright, 1909, and Octave Chanute, 1910. The official presentation of the medal to Professor Bryan will take place next session at a date to be subsequently announced.

## ARMOUR PLATE PLANING MACHINE.

ON the opposite page we illustrate one of two exceptionally large planing machines designed by Thomas Shanks and Co., of Johnstone, N.B., to deal with the very heaviest armour plates yet made. Each machine has a planing stroke of 30ft., while the distance between the uprights is 16ft. 9in., and the distance from the table to the cross slide at its highest is 12ft. From the views given it will be seen that the machines are massive in their proportions, but at the same time the details have been so carefully thought out that only the minimum of floor space is required. All the motions are operated by power, and are as easily and quickly controlled as they are in a small machine.

The bed is of strong box section, and has a considerably increased depth under the tool slides, so that the stresses of cutting may be taken without any yielding of the bed or table. It has three broad flat surfaces to support the heavy weight of the work and the table without undue pressure per square inch, and it is provided with oiling arrangements. The table is 14ft. wide, and is provided with projecting guides to take the pressure of side cutting, one of these guides being fitted with an adjustable strip to compensate for wear. The table is fitted with two steel machine-cut racks set tooth and space, made wide and of comparatively fine pitch, and driven by "bull" wheels of large diameter, so as to ensure smoothness of running and cut. The driving gear, which is entirely of steel, is arranged inside the bed, and is driven by two Lancashire 85 horse-power self-contained motors, carried by a heavy bracket bolted to the bed. These motors are arranged one on each side of a driving wheel outside the bed, and they both are geared to it, this method being employed so as to obtain compactness and practically to eliminate torsion. The table and bed, on account of their great width, are each in two castings with a planed and checked longitudinal joint, fastened together with steel bolts. The cross slide is of great width, is provided with a deep vertical rib, and is formed into a massive box section girder at the back, so as to resist the stresses of cutting at the centre. The particular machine illustrated is fitted with two tool boxes, but where surfacing is specially required it may be fitted with four or more tool boxes. The front tool plates are of steel, and are made broad so that each may carry more than one tool, and the vertical slides are specially long so as to provide for deep grooving. They are fitted with ball thrust washers in the screws, so as to make them easily adjustable by hand. These vertical slides are provided with a quick power motion in either direction. The feeds are self-acting, and are variable and reversible in a horizontal, vertical and angular direction. A quick power motion is provided for moving the tool boxes along the cross slide in either direction, and also for raising and lowering the whole cross slide. The power motion is derived, in this instance, from a motor generator set placed on the top of the heavy cross stay, which braces together the two uprights at the top. The stopping, starting and reversing of these motions is controlled by levers placed in a position convenient for the operator when standing on the floor. The uprights have their slides as wide as the cross slide itself, so that the side tool boxes may in-cut satisfactorily. Each upright is fitted with a balanced side tool box, having a long in-cutting slide, and provided with self-acting reversible feeds in a vertical direction, as well as quick power raising and lowering motions derived from the motor generator set.

The feeds for the various slides, which are derived from the first motion shaft, are entirely apart from, and independent of, the reversing tappets of the machine. The feed mechanism is contained in a gear box on the bed. It is driven by friction from the main motor, and consists of a main cone clutch, held in engagement by a powerful spiral spring, the tension of which can be regulated. For disengaging the clutch there is provided a sliding square bar with a roller at the end, and this bar receives its end movement from a tappet with an inclined face. The tappet is mounted on a flat circular plate, which also carries a fixed tappet for releasing the sliding bar, and allowing the spring to engage the cone clutch. The flat circular plate has a circular T groove for fastening the two tappets so that these can be set any distance apart, and in that way determine the amount of feed within the range. The flat plate is itself driven by wheel and pinion, through a friction disc of special material, which allows a high slipping speed without undue heat. A strong adjustable compression spiral spring provides the frictional pressure, and in this, as in the main spring, efficient ball thrusts are provided to take all end pressure. In addition to the change of amount of feed through the variation of the tappets, a further change is provided by means of sliding spurs in the gear box, so that a very wide range of feeds is secured.

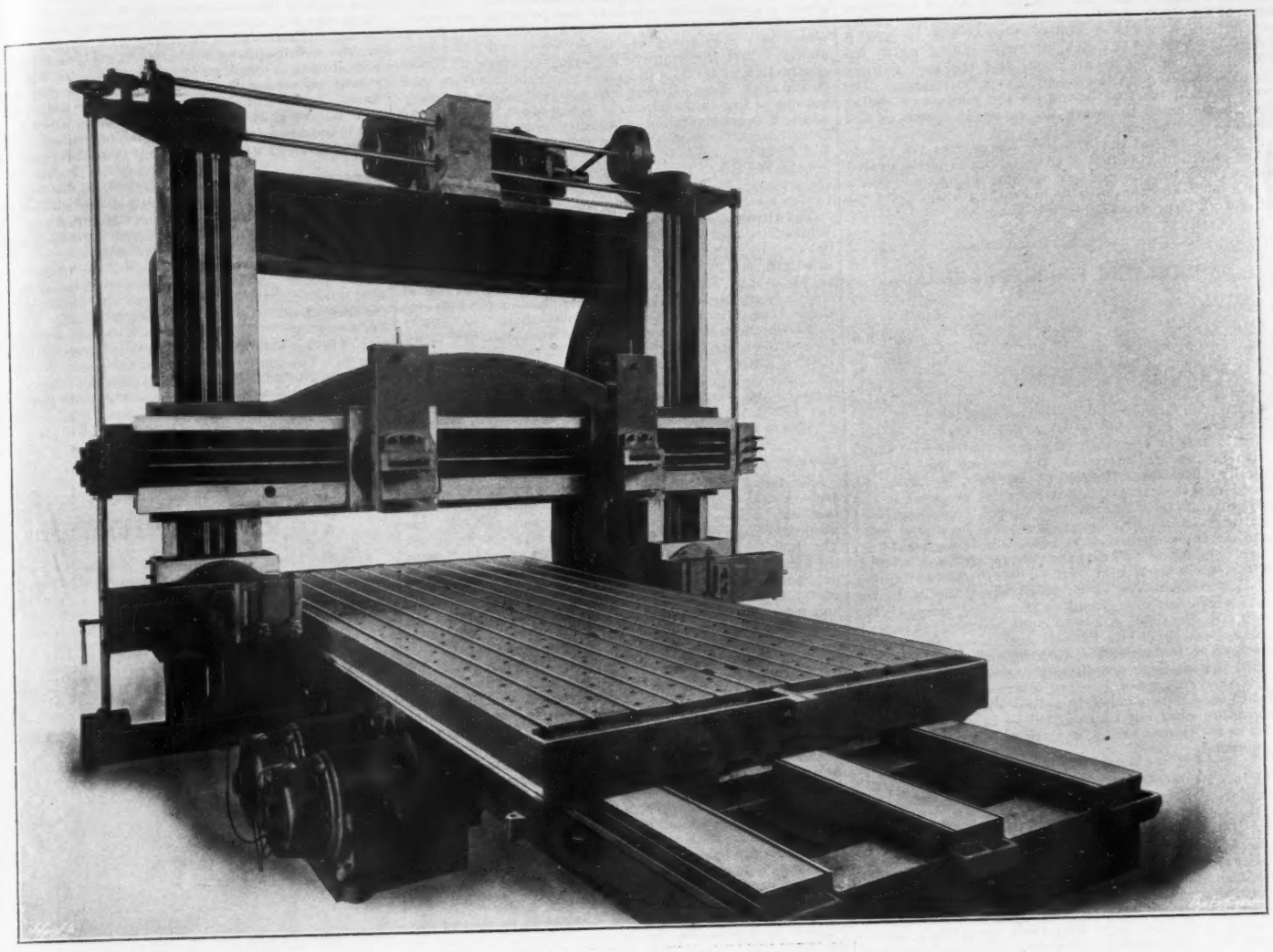
The action of the feed is as follows:—For the purpose of description it is assumed that a feed has just taken place, and that the table is continuing its forward cutting movement. The coned clutch is running loose, and the sliding square bar is in the out-of-gear position, while the flat circular plate is slipping, its rotation being prevented by the inclined tappet being hard up against the square sliding bar. The machine, having come to the end of its forward movement, reverses, and the flat circular plate being now free to rotate brings the fixed tappet into contact with the sliding square bar, and partly releases it. The tappet and flat circular plate being then prevented by the bar from further rotation, slips and the machine continues to run until it reaches the end of the return stroke. Immediately the reverse takes place at that point, the sliding bar is easily released, and this allows the spring to engage the coned clutch, and thus put the feed into action. This feed continues until the inclined tappet again engages the sliding square bar and pushes it back until it is held in its locked position. The coned clutch being thus disengaged, the feed stops. The cycle of movements above described is repeated indefinitely.

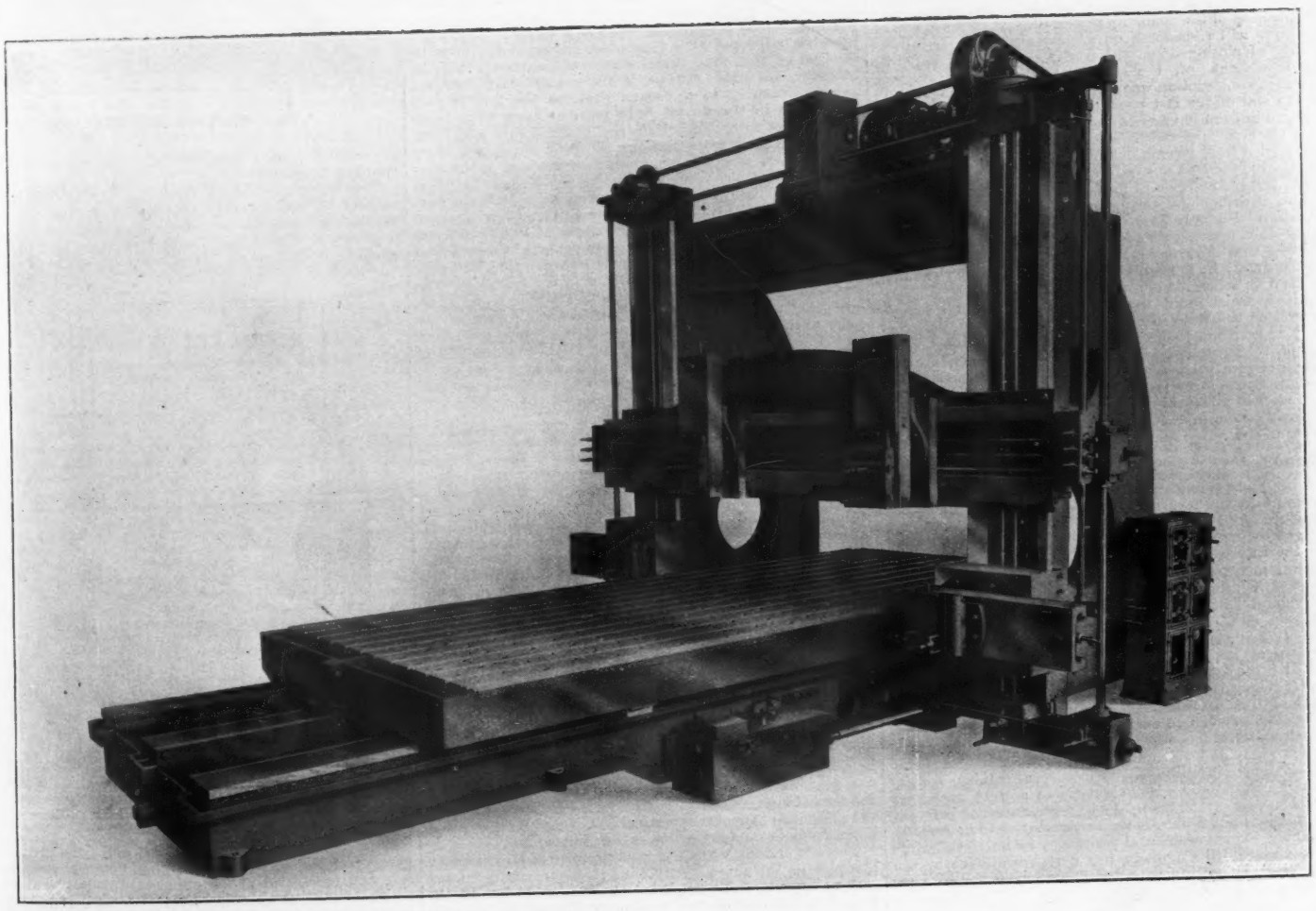
The feed motion is continued through the sliding gears above mentioned, and by a feed shaft—seen on one of the illustrations, between the gear box and the upright—to the bottom of the uprights, where it is connected by a horizontal cross shaft to the vertical shaft, and vertical screws, for self-acting the horizontal cross slide feeds,

# ARMOUR PLATE PLANING MACHINE

THOMAS SHANKS AND CO., JOHNSTONE, ENGINEERS

(*For description see page* 710)





and also the vertical side slide feeds. It is understood that when the tappets are brought to a dead stop against the sliding bar, in each case the flat circular plate slips by means of the friction plate, until the machine reverses, so that whatever the stroke the feed always takes place at the beginning of the cutting movement of the table. A disengaging lever is provided so that the flat circular plate can be put out of action, and a power motion obtained for the various slides, the machine being, of course, at work at the time. For large machines a separate auxiliary power motion motor is employed when the machine is stopped. A lever is provided, by means of which the sliding bar can be drawn back, and the feed entirely disengaged, although the machine may be running. The third lever in the feed box is for the purpose of sliding the change gears to secure the range of coarse or fine feeds, as may be desired.

We are informed that the time taken from the receipt of the order until the first of these machines was delivered was six months, the second machine being delivered a month later, and this without interfering with any of the other work in progress through the shops.

## ENGINEERING PROGRESS ABROAD.

### Argentina.

SOME surprise, and no small amount of concern, has been shown in certain quarters with regard to the proposition made, it may be assumed seriously, that in order to tide over the financial position of Argentina there should be a declaration of a fifty years' moratorium, during which period no obligations, public or private, need be met! Inasmuch as there are several important engineering contracts still in the stage of completion, and in which British houses are interested, the rumour has, not unnaturally, occasioned anxiety. It may, however, be pointed out that so strange a remedial proposal is not likely to find favour with the present Government of Argentina, which, like its predecessors for many years past, has been scrupulously honest with regard to its foreign obligations. During the present year and in 1915, and extending even into 1916, a large number of new irrigation projects are to be undertaken, the estimated cost of which has been placed at 28,594,700 pésos, or, say £2,459,149. Provision has been made to expend at once on these projects, should the financial condition of the country permit, up to the amount of 4,130,932 pésos, or £355,260. Several British firms are directly or indirectly connected with the carrying out of these projects from a constructional point of view, but, as already indicated, the threat of the moratorium need not be regarded as of any importance so far as the due payment for work to foreign contractors is concerned.

### Brazil.

Now that financial conditions in Brazil are improving, and the Government is enabled to see its way out of the many difficulties with which it has been surrounded, it is not improbable that some of the large engineering schemes which were held in suspense will be proceeded with. This remark applies not only to those in the capital, Rio de Janiero, but to some which were either contemplated or commenced in the States, particularly that of Pará, where monetary difficulties have also been exceedingly acute. Among other engineering enterprises which suffered have been those taken in hand by the municipality of Pará Improvements Company, Limited, a British organisation burdened with a very heavy capital. So serious was the position of the company at one time, that the board of directors had considered on various occasions the advisability of closing down the works and making a public announcement of the financial status. All further drainage construction was stopped. This was the position at the end of the last year, but since then, as indicated, matters in Pará have somewhat improved, and it is hoped that the company will be able to proceed without further delay with the carrying out of at least part of this enterprise, which means not only a great deal to the company itself, but to the town of Pará, which it is serving.

The Brazilian Admiralty has decided upon the construction of a new Dreadnought of 30,000 tons, and to carry 15in. guns, to replace the Rio de Janiero. It is thought that Armstrong, Whitworth and Co. will obtain the contract, if, indeed, they have not done so already. It may be remembered that it was the firm of Vickers, Limited, which built the famous Sao Paulo for Brazil, as well as the Bolognesi and the Grau for the Peruvian navy, in addition to La Libertád for Chile. Indeed, Armstrong, Whitworth and Co., Limited, and Vickers, Limited, have between them constructed the greater part of the modern South American navies, but of recent years the United States and Italian contractors have been particularly active in competing for orders from the Governments of these Republics.

### Colombia.

A large amount of British capital has been invested in Colombia in the form of engineering undertakings, more particularly in connection with the railways which, in the greater number of cases, are of British construction. For the future, however, British contractors will have to face an increased competition upon the part of United States rivals, since, as the result of the new treaty between America and Colombia, by the terms of which the latter has been paid, somewhat late in the day it is true, a lump sum of 25,000,000 dols. (£5,000,000) as compensation for the loss of Panama, special favour has been shown to United States contracting firms by the grateful Government. There is no doubt that the United States intend to take full advantage of these important relations, and as an earnest of such intentions a Special Commission has been despatched to Colombia for the purpose of investigating the openings for commercial and industrial enterprise. The Commission is divided up into four sections, and its work is estimated to last eight years and to cost over 400,000 dols. (£80,000). The representative of the Commission, Mr. Miller, is at the present time in Bogotá, arranging for governmental assistance in its work, while the Standard Oil Company has a representative in the same city negotiating with the Government for oil concessions.

Notwithstanding the apparent favour which is being extended to United States firms by the members of the Colombian Government, a strong anti-American feeling is still prevalent in the country, and among private firms and individuals the same preference which has been shown in years past to British firms is not likely to wane on account of the new treaty with the United States. Among other enterprises for which the Government is willing to grant a concession is a railway line between the capital, Bogotá, and the port of Barranquilla. The project would be a very costly one in any case, and in all probability would never prove a paying enterprise. British contractors would do well to seek expert advice from those on the spot before entering into competition for the carrying out of this undertaking. On the other hand, there is a good opportunity of obtaining contracts from the Government for improving the harbours at Buenaventura and Puerto Colombia, as well as for the dredging of the Magdalena River near the port of Barranquilla, whence the steamers leave upon their long and wearisome journey to Girondo, where the railway commences for Bogotá.

The Government has placed an order with Armstrong, Whitworth and Co., Limited, for the construction and delivery of three gasoline launches, each one to be 36ft. in length, 8ft. in beam, and of 4ft. draught, with a speed of 8¼ knots. These vessels are intended for service at the ports of Cartagéna, Puerto Colombia, and Buenaventura. The price agreed upon is £1000 each.

A contract has been entered into to install two lighthouses upon the Atlantic coast of Colombia, one in the shallow waters of Salmedina, at the entrance of Cartagéna Bay, and the other at Isla Fuerte, on the route from Cartagéna to the Atrato River, the Government agreeing to pay £7200 for the erection of the lighthouses, both of which are to be built within two years.

### Greece.

The Greek Government considers that the time has arrived when the long-contemplated improvements at the port of Piræus may be taken in hand, and for this purpose a large credit has been arranged by the Treasury. The Harbour Board has already come to a conclusion as to the form in which these improvements may best be carried out, and also for the practical enlargement of the whole port. It is, for instance, certain that an entirely new and more commodious customs house will be constructed as part of the scheme, with moles and jetty heads, while a special mechanical device of a modern type for the discharging of cargoes will be included. For many years a submerged rock has lain at the entrance to the Piræus harbour; this has already been removed, the amount of rock displaced being 3000 cubic metres, and the cost amounting to £4240. The depth of water now is 8·5 m., equal to about 27ft. 10in.

The port of Piræus ranks with those of Patras, Syra, and Andros, the others of importance being Argostoli, on the island of Cephalonia, Ithaca, and Volo. But fully three-fifths of the entire shipping of Greece passes through the Piræus, the percentage of native shipping being 29·7 of the whole. It is to be hoped that the contract for improving this harbour will be awarded to a British firm, since it is generally admitted by the Hellenic authorities that no better work than that undertaken by British engineering firms can be desired.

At the port of Patras, which ranks next to that of the Piræus in importance, great improvements are likewise contemplated. They will entail an outlay of about £800,000, and plans have already been called for from all parts of the world. The plans selected, which emanate from the office of a French engineer, it is understood, may possibly not be adopted, at least as a whole; they were, however, adjudged by a committee sitting at Berlin to be the best for the purpose, and were voted a prize. There is, however, no great chance of the construction contract going ultimately to a French firm, as the Patras port authorities in times past have been at issue with those Gallic firms with which they had entered into such contracts, and they aver that the contract occasioned them much unnecessary trouble, mainly on account of the continual interference upon the part of the French Legation in Athens. There is, therefore, a strong desire upon the part of the Hellenic authorities to enter into negotiations with a British firm of note. The new works at Patras will call for the reconstruction of the present long sea-wall and breakwater which have been built in order to afford protection to the ships lying at anchor in the harbour. The wall and breakwater cost the sum of £80,000. The work, however, has not been found satisfactory, owing principally to the character of the foundations, which have been laid upon an unsound and shifting bottom, composed of mud and sand, there being an entire absence of rock or other firm substance to form a base.

### Motor Cars in Latin-America.

It is satisfactory to learn that British motor cars are having great success in Argentina. From figures which have been published it would appear that out of 5112 automobiles which were imported into the country in 1913, as against 4281 for the preceding year, England occupied second place on the list of manufacturers. France, however, disposed of more than any other country, heading the list in 1912 with 1651 and in 1913 with 1830 machines; the United States came third, with 708 machines during 1912 and 1296 during 1913. It is not only, however, in the Argentine Republic that British automobiles are proving popular, for Chile also is becoming a regular customer, and now that the roads have been considerably improved in the capital, Santiago, and for many miles around, the demand for first-class cars is likely to increase. It is thought that at first the more expensive machines will be the most in demand, but the cheaper grades will also find a market, and as time goes on the latter are likely to advance in popularity. In other parts of South America, notably in Lima, Peru, a fair number of taxi-cabs have been introduced, but only the cheapest class of automobile has so far been in demand, the trade being confined mostly to the light cars, owing to the financial stringency which is being experienced throughout Peru, and particularly in the capital.

There is enough wealth to give promise of an extensive business in the more costly high-power types of motor cars in Ecuador. Encouraging reports are to hand with regard to the sale of two or three makes of the cheaper class, and there are a few of these likewise to be found in Guayaquil. Here, however, the bad state of the roads prevents anything like an extensive use of motor transport. In the capital, Quito, the thoroughfares are kept in better order, and the principal highway, running out from the capital, is quite suitable for vehicular traffic. In no Latin-American State are more motor cars to be seen than in Panama, especially in Colón, but, naturally, these cars are in the majority of cases of American manufacture. There should be in both of these cities an opportunity of introducing taxi-cabs to replace the miserably horsed and uncomfortable vehicles which are used as public conveyances. In view of the largely increased tourist traffic to both Panama City and Colón, and considering the generally good condition in which the roads are maintained in both towns, makers of motor vehicles should find a continually expanding market.

### Panama.

The biggest dipper dredge that has yet been constructed for and floated upon the Panama Canal has recently been received at Paraiso, where it is now vigorously attacking the Cucaracha slide. The dredge was built in the United States, and it was sailed to Panama the whole way from Richmondport, in New Jersey. The apparatus, and the beam that is destined to carry it, were transported to the Panama machine shops over the Panama Railroad. The dipper has a capacity of 15 cubic yards of spoil at a single operation, which is about three times the capacity of the average dipper. The load carried depends, naturally, upon the nature of the spoil, but approximately it closes at 20 tons. The dredge has proved so successful that the Isthmian Canal Commission has sent an order for a second of the same proportions, and when it arrives it will start work on the same slide, which is still causing much trouble to the Panama Canal authorities.

## NEW MECHANICAL LUBRICATOR.

A NEW form of mechanical lubricator, particularly intended for use on locomotives, has recently been designed and placed on the market by Messrs. C. C. Wakefield and Co., of Cheapside, London, E.C. The particular feature of interest in this lubricator is the fact that the feed can be adjusted by the driver from the cab, so that the necessity for his "going round" the engine while it is running is avoided.

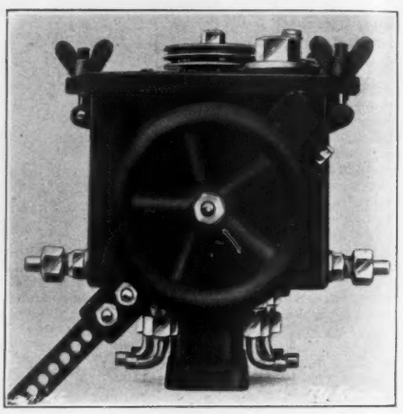


FIG. 1—MECHANICAL LUBRICATOR

The lubricator, apart from the addition of the cab control, is considerably different from the well-known Wakefield lubricator at present in common use. Its design is shown in Figs. 1 and 3, where an eight-feed one-gallon example is illustrated. It consists of a cubical cast iron box with an easily removable lid, and provided with a fixing pedestal on its lower face. Passing through one side and journalled in the opposite wall is a shaft A, on which is formed an eccentric B. This eccentric works between two internal faces on a table C, which is guided

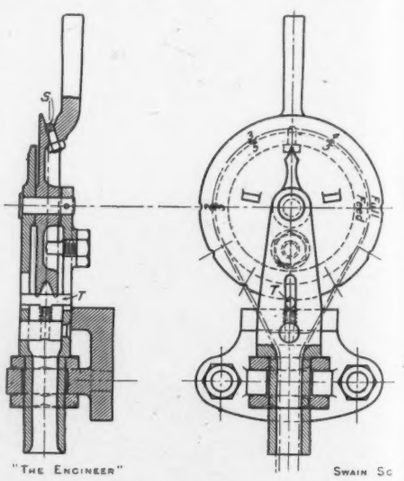



FIG. 2—OPERATING HANDLE IN CAB

in its rising and falling by means of a tail piece D formed on it to work inside the hollow fixing pedestal. The shaft A is rotated by a ratchet wheel E driven by means of the ratchet lever F from any suitable part of the engine mechanism, say, the crosshead.

Between the lips of the table C the heads G of the pump plungers H are situated, there being one such plunger for each feed taken off from the box. Each plunger works inside a pump barrel J rigidly secured to the bottom of the oil reservoir and provided with a non-return ball valve and a delivery pipe. As the table C rises and falls it reciprocates the plungers in their barrels, and oil drawn into the barrels through the ports K on the up-stroke is delivered past the ball valves on the down-stroke as soon as the plunger cuts off the ports K. To make the action surer a sleeve valve L working at all times as if it were rigidly fixed to the plunger is arranged to slide on the external surface of the pump barrel.

The upward motion of the plungers is effected by the contact of the lower lip of the table C with the underside of the plunger heads G. The downward motion is effected by similar contact between the top side of the plunger heads and projections M extending from beneath the upper lip of the table C. It is obvious that by raising or lowering the projections M relatively to the upper lip of the table, a proportionate amount of idle motion of the table takes place, and that during this motion the pump plungers are not operated, so that the feed per stroke is correspondingly reduced. The adjustment of these projections is effected from the cab.

The projections are screw-threaded into the upper lip of the table and on the top side are provided with pinion heads N. These heads are arranged to lie on a circle,

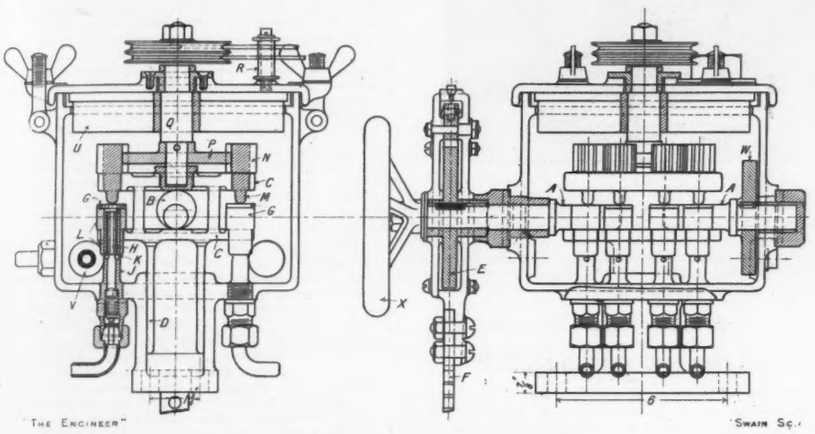



Fig. 3—WAKEFIELD LOCOMOTIVE LUBRICATOR

and are engaged by a toothed wheel P carried by a spindle Q, which is journalled, between collars, in the oil reservoir lid. Operating wires, single or in duplicate, are led round a grooved pulley on the end of the spindle Q. These wires pass between guide drums R, and are thence carried through a tube and round pulleys if necessary to the cab. Here they are attached by the binding screw S—Fig. 2—to the operating pulley. This pulley is provided with a handle, is engraved in terms of the feed, and is notched round its periphery to receive a locating pin T. The bracket on which this pulley is mounted may be conveniently bolted to the side of the cab.

The action of the device should be quite clear from this description of its parts. Returning to Fig. 3, we need only say that U is a wire gauze strainer, V a warming pipe, and W a ratchet wheel preventing the return of the shaft A on the return of the ratchet lever F. A flushing wheel X is fixed to the end of the shaft A, whereby the plungers can be operated by hand at any time without disconnecting the ratchet lever F from the crosshead or other part. A general view of the whole apparatus is given in Fig. 1.

## LETTERS TO THE EDITOR.

*(We do not hold ourselves responsible for the opinions of our Correspondents.)*

### HIGH POWER DIESEL ENGINES.

SIR,—There are several points raised in your article on the above subject, pages 652 and 653 of your issue of the 12th inst., to which I would like to make reference.

Auxiliary exhaust ports with four-cycle engines, besides lowering the mean pressures of the expansion stroke due to early opening and the suction stroke by late closing, would introduce into the cylinder and liner castings certain elements of complication calculated to detract somewhat from one of the principal advantages of the four-cycle engines, viz., the relatively simple nature of the cylinder and liner castings. For instance, it has been found by experience that with engines of any considerable size the exhaust bars must be water-cooled either by boring or coring out water passages therein. To counteract the above drops in pressure by means of a supercharge on the suction stroke, as suggested in your article, requires, if this charge be introduced through the ordinary suction valve, a blower or an air pump of considerable size. Completely to fill, at atmospheric pressure, the cylinder of a four-cycle engine requires 3 cubic feet of air per minute per brake horse-power—assuming a M.E.P. of 75 lb. per square inch on a B.H.P. basis—as compared with 5.7 cubic feet of air per minute per brake horse-power—assuming a M.E.P. of 60 lb. per square inch on a B.H.P. basis—for an average pressure of scavenging air for a two-cycle engine; 75 lb. and 60 lb. per square inch are fair average pressures for continuous running for slow-speed two and four-cycle engines respectively, where all the auxiliaries to the main engine are driven from the main engine, so that for an auxiliary exhaust supercharge four-cycle engine a large pump similar to a two-cycle scavenging pump is required.

Again, a supercharge introduced in this way would have little effect, as the auxiliary exhaust ports are uncovered at the end of the suction stroke. The alternative to provide a separate valve or to make use of the starting air valve already in the cylinder head entails reversing gear for this valve and further complicates the reversing mechanism, cylinder head, &c.

Regarding the arrangement of fuel injection valves described in my paper, it was stated that only the central valve requires the use of compressed air, the other valves being of the "solid fuel injection" type. The central valve is arranged to supply fuel for the power required at the lowest speed of the engine, and so the capacity of the compressor can be greatly reduced.

I am of the opinion that for large cylinders the possibility of "sticking," damage, or breakdown of the fuel injection valve which is supplying the fuel for the combustion stroke of enormous power cannot be contemplated, and multiple valves should be adopted, in which case I recommend the system described.

With reference to the design of cylinder head, as shown in Fig. 39 of my paper, the dished element is made from forged steel. The cast bosses, as suggested in your article, are shown in Fig. 39 (*a*) of my paper. The method of carrying the valves in separate sleeves has been successfully used with ordinary cast iron box section heads. In the cover which is shown in section fore and aft in Fig. 39 three valves, *i.e.*, the fuel injection, starting air and safety valves are provided without any difficulty.

I trust that these remarks will not make too great a demand upon your valuable space.

Greenock, June 16th. JAMES RICHARDSON.

### SURFACE COMBUSTION: A CORRECTION.

SIR,—I deeply regret to inform you that I have discovered that I myself have furnished a very bad example of misusing figures in my last letter. I can only account for it by the fact that after many hours' work in searching and checking literature at hand I had become very tired. Mr. Daman had clearly stated his figures as specific heats, and not as relative mean specific heats. Therefore I, of course, should have halved the increment figures in using them for comparison. I, naturally, willingly and voluntarily apologise for the logical consequences. A friend has sent me Richards' "Metallurgical Calculations," which gives the same values as Mr. Daman. To show the effect of the three sets of reputable values I am now faced with choosing between, I have calculated the sensible heats of the products of combustion given below at a temperature of 1900 deg.

Gases 1 cbm $H_2O + 0.5\,x\,N''$, *i.e.*, products of burning 1 cbm $H''$ in air, in which $N'' = x\,O''$.

| A. | B. | C. |
|---|---|---|
| 2859.1 cals. | 2346.4 cals. | 2451.6 cals. |

Gases 1 cbm $CO_2 + xN''$, *i.e.*, products of burning 0.538 kilos. C in air.

| | | |
|---|---|---|
| 4564.0 | 3751.5 | 4044.9 |

Gases 1 cbm $CO_2 + 2$ cbm $H_2O + 2\,xN''$, *i.e.*, products of burning 1 cbm $CH_4$ in air.

| | | |
|---|---|---|
| 10282.2 | 8444.3 | 8947.1 |

In the above A is based on Beckert Dichmann, B on Le Chatelier (Kietaibl), and C on Richards' and Daman's values on the authority of Mallard and Le Chatelier. Taking values given by Dichmann for the heats of formation of the gases above given, they are 2620 cals., 4344 cals., and 8600 cals. respectively.

As town gases and similar gases are not wholly free from diluents, my suspicion of some overrating of temperatures obtainable appears to be well grounded. The position is very unsatisfactory and disheartening.

Hove, June 23rd. ALLEYNE REYNOLDS.

SIR,—We do not agree with Mr. Alleyne Reynold's conclusion that a sample of coal gas of net calorific value 4700 calories per cubic metre possesses a calorific intensity under 1600 deg. Cent. Practice proves the calculation wrong.

(For BONECOURT SURFACE COMBUSTION, LTD.),
G. W. DAMAN, Secretary.

London, June 22nd.

### GREAT INVENTIONS.

SIR,—I have read the letter of your correspondent "M. Y." with interest, but think that gentleman overlooks certain points. As to the reason why the daily Press is in such a state of darkness over matters connected with engineering and science, I never could make out. At times I have a suspicion that these gentlemen are not quite so ignorant as they appear to be, and they can certainly get the ear of the average public. The man in the street will believe what he sees in a daily paper, and even invest money in it, no matter how cock and bull the description of the new invention or discovery may be, and a refutation of it in a scientific or engineering journal has no effect on his mind whatever, and I could give many actual instances of this. The daily Press is an enormously powerful instrument, and it is no use looking at its weak points only. In fact, it is one of the weak points of the engineer that in many cases he is not so much a man of the world as he should be, and does not appraise general publicity at its real value. If an engineer or scientist has an idea of any value, and is at the same time a man of the world, and, to put it with brutal plainness, something of a showman, he is far more likely to get financial assistance than a man who waits for the public to recognise the merits of his invention or discovery.

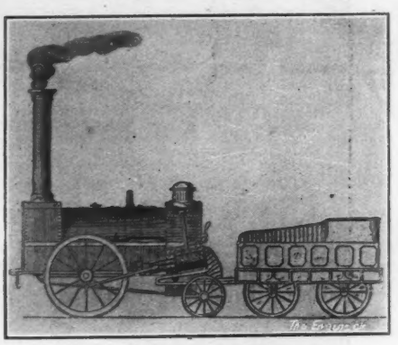
London, June 19th. OWEN LINLEY.

### THE NORTHUMBRIAN.

SIR,—In your last two issues letters have appeared from Mr. John Henry Knight and Mr. James Watt Boulton in reference to this old engine. I beg to enclose you a photograph taken from the *Mechanics' Magazine* of October 16th, 1830, which gave an illustration of this engine on that date. I also give an extract of the description which accompanied it, as I thought these might be of interest:—

"On a subsequent day we travelled from Liverpool to Manchester in an hour and 45 minutes in a train drawn by the Northumbrian, one of the latest made, and one of the best of Mr. Stephenson's engines. An engraving of it ornaments the front page of our present number. It is distinguished from Mr. Stephenson's other engines by having its boiler and chimney of copper instead of iron; but the chief peculiarity in its construction is the addition of a branch tube from the waste steam pipe to the bottom of the furnace, by opening a cock at the end of which the superfluous steam is occasionally drawn through the fire in aid of the combustion—a contrivance somewhat analogous to the exhausting principle of Messrs. Braithwaite and Ericssons.

"The boilers of Mr. Stephenson's engines are all on the tubular



THE NORTHUMBRIAN

plan—consisting of a series of straight tubes of equal diameters enclosed in one general casing and immersed in water.

"It appears from Mr. Booth's account of the railway that this mode of construction, which he calls 'new,' was 'suggested' by him, and that he shared with the Messrs. Stephenson the premium of £500 which was awarded to the Rocket in October last."

The weight of the engine is given as 6 tons 3 cwt.

In the number for October 2nd, 1830, is given the following:—

*First Journey in the Train of the Northumbrian of* 14 *Horse-power.*

From Liverpool to Manchester (weight estimated at 6 tons).

| | Miles. | Min. | sec. |
|---|---|---|---|
| Greatest speed | 1 | 2 | 6 |
| Slowest speed | 1 | 4 | 55 |
| Average speed | 20 | 60 | 0 |

Back from Manchester to Liverpool (weight estimated at 12 tons).

| | Miles. | Min. | sec. |
|---|---|---|---|
| Greatest speed | 1 | 2 | 45 |
| Slowest speed | 1 | 4 | 57 |
| Average speed | 18 | 60 | 0 |

E. W. SARGEANT.

Gloucestershire, June 23rd.

## INSTITUTION OF NAVAL ARCHITECTS.

THE following programme of the summer meeting which the Institution of Naval Architects is holding in Newcastle-upon-Tyne from July 7th to 10th next, at the invitation of the North-East Coast Institution of Engineers and Shipbuilders, and in conjunction with the Institution of Engineers and Shipbuilders in Scotland, has just been issued.

On Tuesday, July 7th, at 10 a.m., the members of the three institutions will be received by the Earl of Durham in Armstrong College, and at 10.30 a.m. will proceed to the reading and discussion of papers in the King's Hall of the College. The following papers will be presented:—(1) "On the Protection of Battleships Against Submarine Attack," by Professor Sir John H. Biles; (2) "Recent Developments of the Hydraulic Transformer," by Professor H. Föttinger; (3) "Shipbuilding Practice of the Present and Future," by Mr. T. G. John; and (4) "Some Notes on the Design of Floats for Hydroplanes," by Mr. Gilbert H. Miller. In the afternoon there will be alternative visits to the naval equipment yard at Walker, Sir W. G. Armstrong, Whitworth and Co., and to the works of Swan, Hunter and Wigham Richardson, Limited, or to the works of the Fullagar Engine, Limited. In the evening, at 9 p.m., there will be a reception at the Assembly Rooms, West Gate-road, by the President—Sir Charles Parsons—and Council of the North-East Coast Institution.

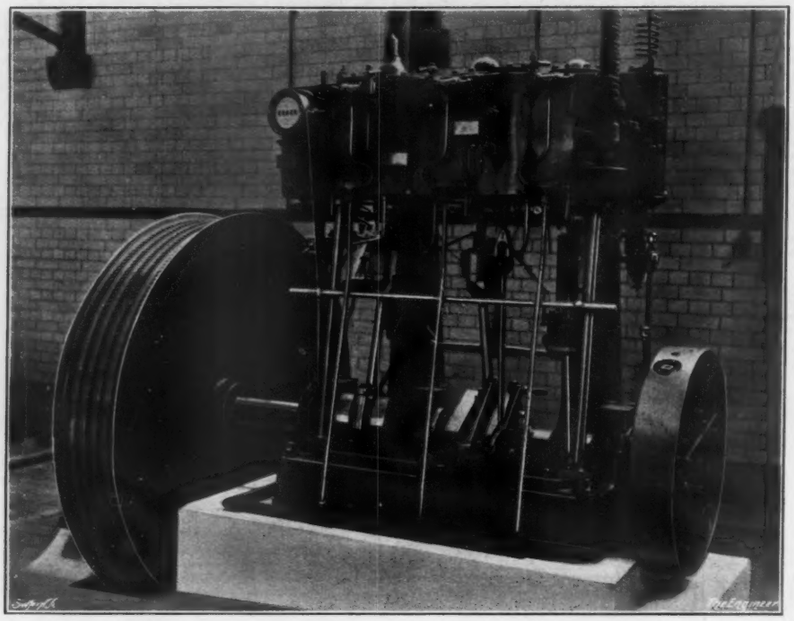
On the Wednesday, commencing at 10 a.m., in the Lecture Theatre of the Literary and Philosophical Society, the following three papers, submitted by the North-East Coast Institution, will be read and discussed:—(1) "Some Notes on Warships Designed and Constructed by Sir W. G. Armstrong, Whitworth and Co., Limited," by Mr. J. R. Perrett; (2) "A Review of the Progress in the Marine Steam Engine on the North-East Coast during the last Fifteen Years," by Mr. A. C. Ross; and (3) "Charging of Two-cycle Engines," by Professor B. Hopkinson, F.R.S. In the afternoon there will be the following alternative visits to:—(*a*) The Consett Iron Company, Limited; (*b*) marine engineering works on the Tyne, including those of the North-Eastern Marine Engineering Company, Limited; (*c*) R. and W. Hawthorn, Leslie and Co., Limited, and Palmer's Shipbuilding Company, Limited; (*d*) The Fullagar Engine, Limited. In the evening at 9 p.m. there will be a reception and dance, at the invitation of the Lord Mayor of Newcastle.

On the Thursday there will be no meeting for the reading of papers, but the following alternative visits have been arranged for the morning:—(*a*) William Doxford and Sons, Limited; (*b*) The Darlington Forge Company, Limited; (*c*) The Fullagar Engine, Limited. In the afternoon there will be a garden party at Lambton Castle, at the invitation of the Earl of Durham.

On the Friday, commencing at 10 a.m., in the Lecture Theatre of the Literary and Philosophical Society, the three following papers, submitted by the Institution of Engineers and Shipbuilders in Scotland, will be read and discussed:—(1) "Influence of Varying Temperatures on the Strength and other Properties of Admiralty Gun-metal," by Professors A. Campion and John G. Longbottom; (2) "The Strength of Welds by the Oxy-acetylene Process;" and (3) "Some Experiments on a Diesel Engine," by Mr. W. S. Burns. In the afternoon there will be a garden party at Jesmond Dene, at the invitation of the Lord Mayor of Newcastle, and in the evening at 7.30 there will be a dinner at the invitation of the North-East Coast Institution of Engineers and Shipbuilders.

# EXPERIMENTAL STEAM ENGINE

W. SISSON AND CO., LIMITED, GLOUCESTER, ENGINEERS



## AN EXPERIMENTAL STEAM ENGINE.

An experimental steam engine has recently been supplied to the London County Council for the School of Marine Engineering and Navigation, Poplar, by W. Sisson and Co., Limited, engineers, Gloucester. This engine, as will be noticed from the illustration given herewith, is of the inverted vertical marine triple-expansion three-crank type, the cylinders being 5½in., 8½in., and 13in. in diameter by 12in. stroke. It has been designed to develop 60 brake horse-power at about 200 revolutions per minute when supplied with steam from a boiler working at 160 lb. per square inch and exhausting into a separate surface condenser affording 25-26in. vacuum. The engine is also arranged to work with exhaust direct into the atmosphere at a lower output.

The cylinder covers are turned and polished inside and the pistons similarly treated all over to diminish initial condensation. The high-pressure valve is of the unpacked piston type and works in a separate liner of nickel alloy with inside steam admission. The medium-pressure valve is also of piston type, but has special packing rings, and the low-pressure valve is of the single ported flat face type. The high-pressure and medium pistons are of cast iron, the former being fitted with three packing rings of special nickel alloy and of the self-spring type, the latter having Rowan patented packing rings.

The low-pressure piston is of cast steel with three rings similar to those of the high-pressure piston, and all three pistons with their rods are made practically equal in weight so as to secure equality of reciprocating masses. The high-pressure piston-rod, which is of special high-carbon steel, is secured to a separate crosshead having a gudgeon on each side arranged to engage with a connecting-rod of the double top end type, such as are commonly used in the largest marine engines. The other two piston-rods are forged solid with the crossheads and have bronze bearings to take the gudgeon, which is secured in the double eye of the connecting-rod, these being all of the ordinary marine type. The high-pressure and low-pressure guides are formed in the two cast iron standards, while the medium-pressure rod has a guide of the cruiser type, which consists of a forged steel bar bolted to the cylinder at the upper end, and to a cross-bar at the bottom attached to the two back standards. The high-pressure connecting-rod has, as before mentioned, a double top end with bronze bearings, the medium and low-pressure rods having forked top ends and gudgeons shrunk in. The high-pressure and medium-pressure bottom ends have "T" feet, bronze bearings, caps and bolts, all in accordance with usual practice; but the low-pressure bottom end has a "semi-solid" or Maudslay end with circular bronze bearings, deep distance pieces and bolts.

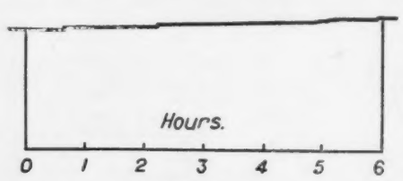
The crank shaft is forged solid of best Siemens steel and has cranks set at 120 deg. apart. This shaft is extended and carried in an outer plummer block to support a brake wheel. The bed-plate is of the deep trough type and has circular bronze bearings fitted into bored seats. The high-pressure valve is actuated by an eccentric sheave controlled by a shaft governor, so as to give automatic expansion, and this governor has a special reversing arrangement to admit of running in stern gear when required. The medium-pressure valve is actuated by the makers' improved single fixed excentric or "elliptic" valve and reversing gear, having all the working joints readily adjustable. For this gear important advantages over the ordinary link motion are claimed. It is pointed out that with it the steam distribution is better; and that there are no sliding working parts, but simply pin joints, so that reversal is easy and any adjustments very readily made. The low-pressure valve is actuated by Stephenson link motion of the ordinary marine double bar type having the gudgeon pins forged solid to take the top end bearings of the excentric rods, the joints being adjustable.

The brake drum, as will be noticed, is secured on the extended portion of the crank shaft and has a dished full plate centre, the rim being arranged for water cooling with internal and external flanges and grooved for five ¾in. ropes 5ft. 6in. diameter of centres. All the usual marine engine accessories are provided, including indicator cocks, pipes and gear, as well as a complete lubricating service, gauges, and a Harding counter.

## LIVERPOOL WATER SUPPLY.

The annual report on the waterworks of Liverpool has just reached us. It is the last to be presented by Mr. Joseph Parry, M. Inst. C.E., who has now been succeeded by Mr. J. R. Davidson, but whose services as consulting engineer have been retained by the Corporation. As in some sort a valedictory address, Mr. Parry has included in this last report of his a highly interesting summary of the history of the Vyrnwy undertaking and of the growth in the demand for and the supply of water in the Liverpool district during the time that water has been brought to the city from the Welsh catchment area. We propose in what follows to give an abstract of this summary.

In the original Vyrnwy scheme it was proposed that eventually a total of 40 million gallons of water should be derived from this source, and the reservoir at Llanwddyn was designed and constructed with this object in view, and having regard to the fact that compensation water to the amount of 13,500,000 gallons had to be sent daily down the rivers Vyrnwy and Severn. It was decided, however, that as regarded the conveyance of the water to Liverpool, a pipe line with a capacity equal to only one-third of the 40,000,000 gallons—*i.e.*, 13⅓ million gallons—should, at the outset, be laid, leaving the second and third instalments, which were to be of a similar capacity, to be provided as and when required. It may here be said that as a matter of fact the pipe line as originally laid had a capacity of between 15 and 17 million gallons a day, so as to allow for possible reduction in capacity due to clogging, &c. The first water reached Liverpool from Wales in the year 1892, and at that period some 25½ gallons a day per head were being supplied from all the sources at the Corporation's disposal to a population of nearly 750,000 persons, the average rate of supply per day being 18,908,000 gallons. Five years later—in 1897—the 25½ gallons a head per day had become 29 gallons, and the total average daily supply had risen to over 23,000,000, the population in the water area having increased to over 790,000. At this time the total resources at the command of the water authorities were approximately as set out in the following table:—

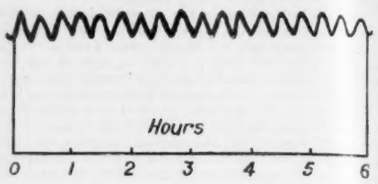



F.g. 1

*Supply of Water Available for Liverpool in* 1897.

| | | |
|---|---|---|
| From the Rivington works .. .. .. | 11,500,000 gals. per day | |
| ,, the Vyrnwy works, say .. .. .. | 16,250,000 | ,, ,, |
| ,, wells .. .. .. .. .. .. .. | 4,000,000 | ,, ,, |
| | 31,750,000 | |

Since the daily average supply had risen to upwards of 23,000,000 gallons per day at this period, it followed that there was then a margin of some 8,000,000 gallons per day on which the Corporation could rely, but it soon became evident that steps would have to be taken to lay a second pipe line between Vyrnwy and the city. Accordingly we find that in January, 1899, Mr. Parry was instructed to prepare plans and estimates for carrying out the second instalment of the Welsh scheme. Owing partly to the high price of iron ruling at the time, it was not till three years later that any further move was made in the matter, but in January, 1902, an expenditure of £785,000 was authorised for the purpose. The contract for the second line of piping was let in March of the same year, and by October, 1905, the work was all completed, saving a balancing reservoir at Malpas and some filter beds. The former, as a fact, was only actually finished last year, and as regards the filter beds, it was decided that they should be added as and when the demand for water rendered them necessary. It will be seen therefore that between the completion of the first part of the scheme,




F.g 2

which was got to work in July, 1892, and the putting in service of the second instalment, which was not completed till October, 1905, a period of over thirteen years had elapsed. During this time, naturally, the demand for water had risen. Its average annual increase had, as a fact, been about 833,000 gallons and the average daily supply had become 29,740,000. It will thus be seen that the daily margin had fallen from something over 8,000,000 gallons to about 2,000,000 gallons, so that the additional supply was only just secured in time.

With the water from the second Vyrnwy pipe line the total amount of water available per day became 31,750,000 plus, say, 16,250,000, or 48,000,000 gallons, and since the demand was at that time 29,740,000 gallons, there was an average daily margin of 18,260,000 gallons. These figures, however, referred to averages. The maximum demand in any one day might rise to as much as between 35 and 36 million gallons. That was the position nine years ago. As regards the state of affairs at the present time, Mr. Parry calculates that during the current year the average daily demand will be about 38 million gallons per day with a maximum demand of about 40½ million gallons. To meet this there is a possible supply of 48 million gallons per day, though this amount may be reduced by incrustation and other obstruction in the pipes. With reference to this aspect of the matter, it is interesting to note that hitherto the effects of incrustation have not been seriously felt in the Vyrnwy pipes. According to Mr. Parry, the latest measurements have shown that the delivery between Oswestry and Prescot is at the rate of 32½ million gallons per day, as compared with the 32½ million gallons measured in 1905. Between Hirnant and Oswestry the delivery has, however, been considerably reduced by the growth of deposits, but it is expected that when these have been brushed out the full delivery will be restored. In the Rivington pipes the incrustation or nodules appear to have reached their maximum growth. There has been no recent falling off in the quantity delivered, and it is not considered probable that there will be any diminution in the future.

The average increase in demand which has been experienced during the last seven years has been at the rate of 1,000,000 gallons per day per annum. Taking the present maximum daily demand as being 40½ million gallons, and allowing for a continuous yearly increase at the rate of 1,000,000 gallons per day, it is evident that there are only some seven to eight years to run before Liverpool will have again come to the end of its tether unless steps are taken in the meanwhile to lay the third pipe line to Vyrnwy. According to Mr. Parry, the decision to carry out this work should be come to at least three years before the date at which estimation indicates that the available supply will be exhausted. As a matter of fact, the actual time taken in installing the second pipe line was about three years and four months.

We may conclude this summary of Mr. Parry's report by referring briefly to an interesting phenomenon which he has observed in connection with Lake Vyrnwy. It appears that, in order to obtain records for statistical purposes of the contents of the lake from day to day, a self-recording float gauge has been installed in a chamber built into the dam. The movements of the float are recorded on a revolving diagram driven by clockwork. These diagrams have shown vertical lines which were evidently not caused by any change in the contents of the lake. In the report are given facsimiles of records taken over two periods of 6 hours. These we reproduce in Figs. 1 and 2. They were both taken on equally calm days and there were no changes visible to the eye in the appearance of the lake and no change in the conditions of inflow or outflow to account for any difference in the records made by the instrument. Yet, as will be observed, the difference in the character of the records is most marked. In Fig. 2 it will be seen that there was a series of most distinct oscillations, and that they occurred with great regularity at intervals of twenty minutes, or three times in the course of an hour. The height of the oscillations is not uniform. It varies with the amount of water admitted to the float, but it also, Mr. Parry observes, varies in a manner not yet ascertained. The phenomenon is being further studied by Mr. Parry, who hopes soon to publish such conclusions regarding it as he has been able to arrive at. He remarks that similar movements, known as *sieches*, have been observed in other lakes, notably in that of Geneva, where they have been carefully investigated by M. Ford, who has written many valuable papers on the subject, and reference is also made to a descriptive account of *sieches* given in the late Professor S. H. Darwin's book on "The Tides and Kindred Phenomena."

# ADVANCES IN THE METALLURGY OF IRON AND STEEL.*

By SIR ROBERT HADFIELD, F.R.S.

THE name of our Society, "The Faraday Society," is one to conjure with, and one that we may well feel proud to own. The name has always appealed to me, because Faraday, apart from his other scientific work, paid no small attention to the particular corner of scientific research to which I personally have devoted most of my life. In the course of his numerous discoveries were :—Induction currents, which eventually gave us electric light and the electric motor, the law of chemical decomposition in electrolysis styled Faraday's law, diamagnetism, the action of magnets on polarised light, the liquefaction of carbonic acid gas and of protoxide of nitrogen, and many others of importance. Moreover, of the greatest interest of all to me was the attention bestowed by Faraday on the fascinating subject and particular corner of scientific research to which I have devoted a large portion of my life, the study of the numerous alloys of iron with other elements. Although Faraday was not the first in this field, yet he was certainly one of the pioneers. This is indicated and set forth in his admirable papers on alloys of steel.† The extraordinary advances which have been made throughout the world during the last generation, one might say within the last twenty years, have been largely owing to the study and introduction of new combinations of iron with other elements.

*Early Metallurgy and Alloys of Iron and Steel.*—The problem of alloys of carbon and of many different elements with the world's leading metal, iron, is an extraordinarily fascinating one. I use the qualificative "leading" advisedly, since without this metal the world would be plunged into uncivilised darkness, and when this metal does fail, for fail it must at some future time, it is difficult to see how the world can avoid returning to the Stone Age at a quicker pace than that at which it emerged from it. Iron is in truth the leading metal. It is constantly used and in everybody's hand and service in some shape or other, and for an immense variety of purposes ; yet we all recognise that it still embodies a vast amount of secrets ; it still affords a wonderful field for research.

*Faraday's Experiments in* 1822.—From Tubal Cain to Faraday is a far cry indeed. The latter, our revered master, whose name has so wisely been adopted by our Society, was one of Britain's noblest sons. In the earlier years of his activity he attacked the problem for the sake of the problem itself. His whole life was one of untiring energy, and a detailed record of his researches would fill volumes of any Institute's "Proceedings." He devoted a certain amount of attention to the study of metallurgy. As regards his metallurgical research work, fully described in the source to which I have previously referred, it was in 1822 he mentioned in one instance that he himself could not go to Sheffield, where he intended to have his alloys made in continuance of the experiments he and Stodart had started at the Royal Institution, but that he was carefully preparing in London the mixtures to be melted in Sheffield, placing them in separate parcels. The work was to be given to a trusty assistant, who was to go down and see the experiments put in hand and completed at Sanderson's works, this firm being still in existence to-day. In those early days there was only one way of sending the specimens from London to Sheffield, that is, by coach, a long journey, and one can picture the great scientist carefully sorting out his materials, various alloys and iron, for mixing together in order to produce the different classes of material he had in view, and carefully packing them in different parcels.

Faraday foresaw that metallurgy was destined to become one of the leading branches of science, and that in a general way it is upon progressive metallurgy that most of the advances in modern effort and progress are dependent. I say this advisedly, for what would life be to-day without the aid of the metal iron and its alloys and combinations ? This was pointed out very fully in my presidential address to the Iron and Steel Institute in 1905. So much was I then imbued with this spirit that in that address I gave the portraits of some twenty-one early scientists, largely Swedish, to whom the world owes such a great debt of gratitude with regard to the work they did in first separating many of the various elements now used in the alloys of iron and steel. Probably in no country was more good work done than by these early scientists in Sweden.

*Conservation.*—I may add, although it may seem a truism, that the investigation of alloys of iron is exceedingly important and of great practical benefit and utility not only from the point of view of obtaining the required combination for a given purpose, but also from that of obtaining for a given quantity of metal the maximum degree of utilisation. As above alluded to, the world's resources in the matter of iron ores are not inexhaustible, and it may be incumbent upon us before long more carefully to husband them. The United States is now annually producing no less than thirty-three million tons of pig iron, Germany some twenty million tons, Great Britain, France, and Belgium nearly as much more, all involving enormous consumption of iron ore. Quite apart from these two points of supreme economic interest, the study of alloys, as I have already stated, is a most fascinating study and indeed a very wide one.

The rapid introduction of alloys of iron with other elements shows that they have met the necessity of the times. An alloy steel, although it is more expensive, is really an attempt at conservation ; it is possible to make a pound of alloy steel go as far as many pounds of ordinary steel.

As some amongst us have said that because other nations have now passed us in our output of iron we must be decadent, it is hardly necessary to point out that, notwithstanding our having gone to the third place from the production point of view in pig iron, we were never so prosperous as to-day. Therefore the mere tonnage production is not entirely an index, so long as we have cheap sources of supply where the ore or the pig or bar iron can be obtained. It must be remembered, too, that, as in the past, the production of iron by different countries must vary from time to time. The country leading at one period may not necessarily do so for all time. The great and leading point is to provide for a source of supply of the ore.

The well-known French writer, Henri Gaston, in his interesting brochure "Où va l'Allemagne," points out that Germany will in the near future exhaust her own supply of iron ore ; then what is she going to do ? She controls no outside sources of any great value. Without introducing politics, perhaps there was more than met the eye in Germany's interest in Morocco, with its great stores of iron ore. Gaston claims that France has a much greater and more certain metallurgical future. He goes so far as to say : "Nous sommes destinés, si rien ne vient contre carrer nos desseins, à devenir la nation métallurgique la plus puissante du monde." I have written these few remarks to show that any temporary heading of the list of nations producing pig iron cannot by itself alone be considered. There are many other factors.

*French Metallurgy in the Eighteenth and Nineteenth Centuries.*—Two remarkable books were published in 1846, one "L'Art de Tremper les Fers et les Aciers," by M. Camus, and the other "Mémoire sur la Fabrication et le Commerce des Fers à Acier dans le Nord de l'Europe," by M. F. le Play, Ingénieur en Chef des Mines, Professeur de Métallurgie à l'Ecole Royale des Mines. That by M. Camus, who is described as "Ingénieur-Manufacturier, membre de la Société d'Encouragement pour l'Industrie Nationale, ex-Ouvrier Contre-Maitre et Directeur-Fondateur de plusieurs Usines et Manufactures Métallurgiques en France," deals in a most practical way with the methods required to obtain the best qualities from steel which has to be hardened and tempered. Much of the information he gives is quite as applicable to-day as when it was first written. He furnishes particulars of various temperatures as they were then estimated by the Wedgwood pyrometer, heat colours, and other information.

Turning to the work by Professor le Play, this writer shows how for a hundred years or more French metallurgy, as regards the production of high-class steel, had been entirely misdirected by the idea to which the French metallurgists obstinately clung for so long, that it was possible to produce in France bar iron for making steel of the same quality as produced by Sweden, this, too, in the face of the wonderful progress then made by the English steel makers, who had wisely adhered to the importation of high-class Swedish irons. This book has for the first time made me aware that Réaumur‡ (by his elaborated researches published from 1720 to 1722), although a great scientist in many ways, made a terrible mistake, which hampered French industry for a long period, when he proved to his own satisfaction, as he thought, that it would be possible to treat irons made in France so that their quality would be equal to the pure products of Sweden. Owing to his misapprehension of the true conditions attaching to the production of high-class steels, very large sums of money were lost in France both under the Monarchy and the Republic. This shows how exceedingly careful a scientific man should be in advancing theories not fully tested and confirmed in practice.

The position which had already then been reached by Sweden is but another proof of the debt of gratitude the metallurgical world owes to that country. As Professor le Play said in 1846, page 91 : "For two centuries the Swedish metallurgists have exploited with great cleverness the steel making quality of their minerals. This branch of the metallurgy of iron is due to their efforts. Understanding that the success of cementation steel works rests essentially on the confidence which the manufacturer may feel in the raw material, they have made every individual and collective sacrifice which the scrupulous maintenance of the qualities represented by the trade marks necessitated. Hence, for example, the establishment of these 'Jern-Vagen' model institutions for all commercial people, which, by a rigorous control over the quality of the products, guarantees the entire industry of the country against the divergences which might be prompted by private interests. It is therefore to the intelligence and the commercial integrity of the Swedish ironmasters, no less than to the genius of Yorkshire manufacturers, that is due the expansion of this new art, which, placing henceforth the steel industry within the means of every nationality, has come to subserve one of the most pronounced tendencies of modern society, and which, by a large output of steels of greater perfection and, above all, harder than the natural steels, has endowed our civilisation with means of action proportionate to the magnitude of the control which it exercises over matter and to the greatness of the results it seeks to attain. The facts revealed in this paragraph prove that Swedish metallurgists have been able to place themselves, so far as they are concerned, at the head of this noble mission, while everything appears to indicate that they will know how to maintain that position."

Professor le Play points out (page 99) how it was that Réaumur, clever as he was, had gone wrong :—"The disastrous results from which the French steel industry suffered, by following the advice of Réaumur, did not change the opinion of the practicability of the process, although based merely on laboratory experiments. The most distinguished scientific men and the most eloquent writers persisted in maintaining that French iron was very suitable for steel making, and the Government, much influenced by their arguments, continued to insist on the use of this iron as a condition in making any grant to assist any infant industry."

Works after works in France came to grief owing to the obstinacy with which the French clung to their methods of trying to utilise their own Empire's products at the expense of quality. Even when works were started, as, for example, those of Aciéries de Nerouville in 1770, where Swedish iron was exclusively used, special pressure was brought to bear to compel them to discontinue using the imported product, researches being renewed in order to try and utilise French iron, again only with the same disastrous consequences.

Professor le Play further points out (page 132) :—"As I have already said, if Réaumur, in 1722, had not misled those engaged in the industry, it would have developed, as in England, by using Swedish iron. It would have done it with probable success, since, during the whole eighteenth century, England believed it should lay taxes on the right of importation of foreign iron."

I have given the foregoing at some length because it is interesting to see that our British common sense and our practical way of regarding matters of this kind kept us on the right road. It was good judgment of no little value, for it resulted in Sheffield becoming the centre of the special steel trade of the world, a position which it still holds. The French idea was that the quality of the material then known as "body" was to be obtained by purifying the products of their more imperfect ores. But, as we all know, this was not practicable, and Sweden still holds its position in the world for the production of the purest quality of raw material. There is more Swedish pig and bar iron now being used than at any previous time.

Le Play also mentions, and I think this is specially interesting in view of Faraday and Stodart's experiments in 1820, that these commenced owing to Faraday's having analysed certain specimens of material from India known as Wootz steel. A similar series of experiments were then undertaken in France. Assistance was given to the project by the well-known Société d'Encouragement pour l'Industrie Nationale, a Society still existing and doing most excellent work. This Society found the necessary funds for carrying out some three hundred experiments upon alloys of iron with different metals. A report on this subject was presented to the Society in 1821. The experiments were continued to the year 1824, but did not appear to result in any manufacturing benefit. The Société d'Encouragement pour l'Industrie Nationale then granted gold medals to several investigators in the art of steel making.

*Value of Research.*—Let us remember that it is to the valuable properties of the many alloys of iron now made, from carbon steel to the complex one known as high-speed tool steel, which contains no less than five different elements apart from the iron itself, is due the remarkable progress we have made, whether in the arts of peace or war. I will give one simple concrete instance—the modern motor vehicle, whether for private or trade use, with which such an enormous traffic is now carried on with so great convenience and comfort to the public of all lands. Take away the alloy steel used in its construction, and it could no longer be produced. The combination of lightness and strength necessary in such modern products is only possible by the use of special alloy steels.

To study the qualities of alloys of iron with other elements involves much research work, which is a noble occupation for mankind. Whilst this work may not appear so attractive as the discovery, for example, of a new element, it is not less important. The value of research work was early recognised in this country, for in the very interesting "History of the Royal Society of London for the Improving of Natural Knowledge," published in 1702 and written by "Tho. Sprat, D.D., Lord Bishop of Rochester," it is said in the preface or dedication portion to the King (Charles II.) that "Of all the kings of *Europe*, Your Majesty was the first, who confirm'd this Noble Design of *Experiments*, by Your own Example, and by a Public Establishment of the Royal Society. An *Enterprize* equal to the most renoun'd Actions of the best *Princes*. For, to increase the Powers of all Mankind, and to free them from the bondage of Errors, is greater Glory than to enlarge *Empire*, or to put Chains on the necks of Conquer'd *Nations*. A higher degree of Reputation is due to *Discoverers*, than to the *Teachers of Speculative Doctrines*, nay even to *Conquerors* themselves. Nor has the *True God* himself omitted to show his value of *Vulgar Arts*. In the whole *History* of the first *Monarchs* of the World, from *Adam* to *Noah*, there is no mention of their *Wars*, or their *Victories* : All that is Recorded is this, They liv'd so many years, and taught their *Posterity* to keep *Sheep*, to till the *Ground*, to plant *Vineyards*, to dwell in *Tents*, to build *Cities*, to play on the *Harp* and *Organs*, and to WORK IN BRASS AND IRON. And if they deserv'd a *Sacred Remembrance*, for one *Natural* or *Mechanical Invention*, Your Majesty will certainly obtain *Immortal Fame*, for having establish'd a perpetual Succession of *Inventors*."

Quaint as may seem these words to us of to-day, there is indeed still now as great truth in them as when they were uttered. The marvellous recent progress of the world has been largely due to the scientist, to the inventor, and not least in these branches of human thought are those who work in "natural or mechanical invention," or, to use again the Bishop's words, "in brass and iron," though nowadays the latter metal plays the more prominent part.

Since the date when these wise words were uttered the Royal Society has seen one long-continued career of success, and owing to the devotion of its Fellows to the cause of science and scientific progress, mostly without reward of any kind, there is no country where science and scientific work is more highly esteemed than in Great Britain. I know it is often customary to say that we lack appreciation of scientific merit, but I do not believe it. The fight for the cause of advance may be severe here, but in the end we English recognise to the full true merit. We need not be ashamed when from this little island have come, not to mention those still with us, such men in the Anglo-Saxon race as Bacon, Newton, Priestley, Dalton, Boyle, Cavendish Faraday, Davy, Huxley, Tyndall, Spencer, Darwin, Kelvin, Thompson, Dewar, Rayleigh, Oliver Lodge, Percy, Roberts-Austen, and many others. On the more technical side, Dudley, Sturtevant, Pettus, Huntsman, Darby, Kirwin, Cort, Heath, Heaton, Mushet, Bessemer, Siemens, Bell, Whitwell, also many others in the Old World. In the New World, such men, as regards both classes of research, as Benjamin Franklin, Fulton, Agassiz, William Gibbs, Rowland, Barus, Edison, Bell, Steinmetz, Sterry Hunt, Howe, Holley, Fritz, and others who are referred to in the earlier part of this address.

The foregoing list is necessarily a very incomplete one, and refers only to the workers in the Anglo-Saxon race. It, however, represents at any rate some of those who have done the greatest work in the domains of the sciences of chemistry, physics, electricity, engineering, and metallurgy.

Our Society in execution of its own smaller, but, I think, laudable programme has always endeavoured to contribute to the increase in the general stock of human knowledge, and our very title is an earnest that we, like Faraday, are searching for information regarding unknown phenomena with a view to a general increase in the comfort and progress of mankind.

*The Author's Research Work.*—At the time I first started my own research work, in 1882, little was known on the subject of alloys of iron. In fact, in the light of our present knowledge, one might safely say that the subject was practically an unknown one. Mars, the eminent German writer, in his recent book, "Die Spezialstahle," has been good enough to say : "The most extensive experimental researches, which may be said to have laid the foundation for entire knowledge of steel alloys, were carried out by Hadfield in the eighties of the last century. . . . . His two works on manganese steels and silicon steels have become of decisive importance as regards the development of the technics of steel alloys. They not only supplied a wealth of important facts from the purely scientific point of view, but they subsequently led up to the evolution of many new qualities of steel. . . . The first thorough researches concerning silicon and iron alloys which could claim to have investigated the properties of silicon steels from the standpoint of the steel manufacturer, with a view to the uses of the alloys examined, were published by Hadfield. This work was the second of the series of publications forming the foundation of the entire modern knowledge of alloys of iron."

Pourcel, the distinguished French metallurgist, said that he "considered the production of manganese steel the most important event in practical metallurgy during the last ten years, and which might take its place beside the result of the labours of Gilchrist, Bessemer, Siemens, Martin, and Mushet."

Dumas, in his "Recherches sur les Aciers au Nickel à Hautes Teneurs," said that my alloy studies were "the first publications which had been made upon alloys containing high percentages of elements other than iron." Bradley Stoughton, in his excellent work, "The Metallurgy of Iron and Steel," was good enough to make similar comments. Finally, Osmond, the great French scientific metallurgist, said that my discovery of manganese steel was of the same order and equalled in importance the discovery in past centuries of the effect of quenching upon carbon steel.

I have referred to these quotations in order to show the truth of my earlier remarks that when first starting my labours in the eighties of the last century the general knowledge available on this subject was very small indeed. In this connection I should like to add that the conception which formerly ruled in regard to the term "alloy" prevails to this day in the mind of the general public. An alloy to many implies nothing more than the addition of a baser metal to a finer one, the object of the mixing of the two together being to obtain a cheaper commercial article and one that will wear better. This, we all know, is not at all the case in regard to special steels and special steel alloys or combinations of the present day. The definition of the word "alloy" might better be made to read "the combining by fusion of two or more metals together, or of a metal with one or more metalloids, for various specific purposes."

*Effect of Carbon upon Iron.*—In the matter of alloys of iron with other elements the fact should not be lost sight of that carbon still pre-eminently holds a position of supreme importance, for the presence of carbon even in special alloy steels is, with some few exceptions, absolutely necessary. Take as an illustration high-speed tool steel, which has led to such an enormous saving in machine shop practice, with consequent benefit both as regards quicker and greater output, combined with greater precision of execution. Whilst the carbon present need not be relatively high, yet there must be sufficient carbon present, otherwise the cutting properties of the steel in question would not be attained. The explanation is probably as follows : In high-speed tool steel of modern composition there is usually about 16 to 20 per cent. of tungsten, 2 to 4 per cent. of chromium, and about .70 per cent. of carbon. Before treatment of the steel the carbon exists in the form of carbide carbon and hardening carbon as defined by Ledebur.

| | Per cent. |
|---|---|
| Hardening carbon .. .. .. .. .. .. | .18 |
| Carbide carbon .. .. .. .. .. .. | .56 |
| Total carbon .. .. .. | .74 |

After treatment, and with the nose of the tool in the condition required for mechanical work, we find the carbon content to have been transformed into

| | Per cent. |
|---|---|
| Hardening carbon .. .. .. .. .. .. | .60 |
| Carbide carbon .. .. .. .. .. .. | .14 |
| Total carbon .. .. .. | .74 |

Therefore, when we talk about the wonderful effect of the addition of elements other than carbon to iron, we must not fail

* A presidential address delivered to the Faraday Society on Thursday, June 11th, 1914.

† Faraday's papers on the alloys of steel (Faraday and Stodart) were read on March 21st, 1822, and appear in the "Philosophical Transactions" of the Royal Society for that year (page 253) ; also in the *Philosophical Magazine*, Vol. IX., page 363. An interesting report of his various experiments will also be found in his work entitled "Experimental Researches in Chemistry and Physics" (1859).

‡ One of Réaumur's well-known books was "L'Art de Convertir le Fer Forgé en Acier" (Paris, 1722).

to recognise that many, if not all, the new properties acquired by the steel are due entirely to the marvellous change that the treatment has wrought in the form of the carbon present, that is, its transformation from the soft or carbide carbon into what is believed to be the hardening or hardenite form of carbon, that is, the alloy elements which enable the hardening carbon—or call it what you will—to retain its hard cutting properties in the steel. Whilst a similar change occurs by heat treating any low-carbon steel—that is to say, carbon steel without other modifying elements present, or present in very small percentages only—the chromium and tungsten in high-speed alloy steel maintain, or assist in maintaining, the hardenite present in that form, so that the cutting edge does not lose its hardness even when quite a considerable degree of heat caused by frictional contact is reached, which would entirely soften ordinary carbon steel.

*The Author's Experiments on Alloy Tool Steel.*—These remarks are based on experiments which I carried out as far back as 1903 with two grades of steel. The results of these experiments have not until now been published, so attention is specially drawn to them for the reason that they illustrate the very great importance of the metalloid carbon. One of the alloys experimented upon had the following composition :—

| C. | Si. | S. | P. | Mn. | Cr. | W. |
|---|---|---|---|---|---|---|
| .74 | .10 | .04 | .03 | .28 | 2.84 | 18.00 |

The physical characteristics of this material (No. 73) were as shown in the following Tables I., II., and III. It was tested in

TABLE I.—*Tensile Tests.*

| | | | |
|---|---|---|---|
| No. of test bar | 6517F | | 5563F |
| Forging or casting | Forging | | Forging |
| Machined or forged | Machined | | Machined |
| Taken from | Bar 1in. square | | Bar 1in. square |
| Transverse or longitudinal | Longitudinal | | Longitudinal |
| Pattern | No. 2 | | Brayshaw |
| Treatment | Annealed | | 2in. × .564<br>Air hardened at white heat |
| Permanent set | 11, extensometer | | 46.5, extensometer |
| Breaking load | 52 | | 69.2 |
| Elongation, per cent. | 14.5 | | Nil |
| Reduction in area, per cent. | 18.64 | | Nil |
| Ball test | 255 | | 627 |

TABLE II.—*Static Fremont Test.*

| | |
|---|---|
| Number of test bar | 6699F |
| Forging or casting | Forging |
| Machined or forged | Machined |
| Taken from | Bar 1in. square |
| Transverse or longitudinal | Longitudinal |
| Pattern | 10 × 8 × 30 mm. |
| Treatment | Annealed |
| Maximum load, kilos. | 2100 |
| Energy static, kilo. | 0.18 |
| Angle | 3 deg. |

TABLE III.—*Compression Tests.*

| | | |
|---|---|---|
| No. of test bar | 5695F | 5194F |
| Forging or casting | Forging | Forging |
| Machined or forged | Machined | Machined |
| Taken from | Bar 1in. square | Bar 1in. square |
| Transverse or longitudinal | Longitudinal | Longitudinal |
| Pattern | .7 × .564 | .7 × .564 |
| Treatment | Annealed | Air hardened at white heat |
| Elastic limit— | | |
| .25 per cent. set | 18 tons | 135 tons |
| 2½ per cent. set | 53 tons | Over 200 tons |
| 5 per cent. set | 61 tons | Over 200 tons |
| Total set | 25.7 per cent. | .143 per cent. (crushed at 284 tons per sq. in.) |
| Ball test | 235 | — |

two conditions—(*a*) annealed, (*b*) air-hardened at white heat. As regards the electrical qualities of this material, these are as follows. The permeability and retentivity or coercivity were determined by the electrical department of the Hecla Works Laboratory.

Tests were carried out on the steel No. 1908D, the following results being obtained :—

TABLE IV.

| Treatment. | Electrical resistance. Microhms per c.c. |
|---|---|
| "As forged" | 40.79 |
| 775 deg. furnace | 31.37 |
| 1200 deg. air | 56.53 |

Magnetic tests on the same material are shown in Figs. 3, 4, 5. It will be seen from the heating and cooling diagrams that the magnetism probably disappears at a temperature of about 800 deg. Cent. on heating and reappears at 750 deg. to 735 deg. Cent. on cooling, that is, in the Ar 1-2-3 point.

*Tool Steel of Lower Carbon Percentage.*—With a view to ascertain the effect of a lower percentage of carbon upon the alloy, the steel marked No. 73J was also prepared, having the following composition :—

| Mark. | C. | Si. | S. | P. | Mn. | Cr. | W. |
|---|---|---|---|---|---|---|---|
| 73J | .35 | .10 | .03 | .03 | .33 | 2.82 | 18.95 |

It will be observed that this steel, containing .35 per cent. of carbon, was thus of the same composition as regards the "determining" elements—that is to say, those elements which are known as the special elements entering in the composition of high-speed tool steels, but the carbon percentage, say, about half. It was heat-treated in a similar manner to that carried out upon the specimen marked No. 73. It was, however, found to be quite useless for tools, being soft, and would not carry any cutting edge. There was practically no hardenite or hardening carbon present in this steel ; the carbon was almost entirely in the form of carbide carbon.

On the other hand, the steel No. 73, after heating to about 1100 deg. Cent. and cooling in air was found to contain no less than .60 per cent. of hardenite, or hardening carbon, a circumstance which fully explains its valuable cutting properties. The following table, which refers to this steel No. 73, will be found interesting :—

TABLE V.

| | |
|---|---|
| Mark | 73 |
| Before treatment— | |
| Carbide carbon | .56 |
| Hardening carbon | .18 |
| After treatment— | |
| Carbide carbon | .14 |
| Hardening carbon | .60 |
| Ball hardness— | |
| Before treatment | 255 |
| After treatment | 565/760 |

This material cannot be properly self-hardened. This is very remarkable in view of the fact that it contains nearly 19 per cent. of tungsten and nearly 3 per cent. of chromium, that is, nearly 22 per cent. of special elements, leaving only 78 per cent. of iron. The reduction from about .70 per cent. carbon to .35 per cent. has made it impossible for the material to become hard.

It will be noticed that this steel, No. 73J, containing .35 per cent. carbon, possesses in the forged condition a ball hardness of 202 ; after cooling from 885 deg. Cent. its hardness is 184 ; after cooling from 1140 deg., also 1160 deg. Cent., its hardness is 161 ; in other words, there is no increase in hardness.

We have thus in the above a very clear proof of the correct value and action of carbon. From this it will be seen that the same element, carbon, which is so important in carbon steels, and in other special steels, is of equal importance to the modern high-speed tool steels. If you leave out carbon from the latter the material is practically useless for the purpose in view. There could not be a stronger evidence of the importance of this element carbon, acting as it does in the presence of no less than three other important constituents, namely, manganese, chromium, and tungsten.

As will have been noticed, the second specimen, steel No. 73J, contained high percentages of chromium and tungsten, nearly 22 per cent. of these two elements together (2.83 and 18.95 per cent. respectively), but the carbon content had been reduced to .35 per cent. This percentage of carbon in itself may be considered fairly high, and one might have expected that under the influence of the high percentages of chromium and tungsten present there would have been some hardening effect upon a tool made from steel of such a composition. When cooled in an air blast from white heat—this treatment being the same as that carried out upon the specimen No. 73—also quenched in water from a bright red or a white heat, the tool made of the steel No. 73J in each case remained quite soft. This illustrates in a marvellous way, as I have said, the influence of carbon. In other words, the effect of this lower percentage of carbon, as compared with the proper percentage for high-speed tool steel, is much the same at this low figure, as the effect that would be obtained were there no chromium or tungsten present. After quenching there was no hardening carbon or hardenite formed. On the other hand, by increasing the carbon to the not very high point of .74 per cent. (specimen No. 73), then the remarkable properties of high-speed tool steel were obtained. The physical

TABLE VI.—*Tensile Tests.*

| | |
|---|---|
| Number of test bar | 6516F |
| Forging or casting | Forging |
| Machined or forged | Machined |
| Taken from | Bar 1¼in. dia. |
| Transverse or longitudinal | Longitudinal |
| Pattern | No. 2 |
| Treatment | 1100 deg. air, 810 deg. furnace |
| Permanent set | 22 |
| Extension at permanent set | .002 |
| Breaking load | 49 |
| Elongation, per cent. | 20 |
| Reduction in area, per cent. | 33½ |

TABLE VII.—*Fremont Tests.*

| | | |
|---|---|---|
| No. of test bar | 7725F | A5195, A5196 |
| Forging or casting | Forging | Forging |
| Machined or forged | Machined | Machined |
| Prepared from | Test bar 6516F, 1¼in. dia. | Bar 1¼in. square |
| Transverse or longitudinal | Longitudinal | Longitudinal |
| Pattern | 10 × 8 × 30 mm. | 10 × 8 × 30 mm. |
| Treatment | 1100 deg. air, 810 deg. furnace | 725 deg. furnace |
| Nick test : "C" nick | 2 × 3 deg. | 2.5 × 2 deg. |
| No nick | 20 × 45 deg. | 8 × 22 deg. |
| Ball test | 196 | 217 |

characteristics of the steel No. 73J were as shown in Tables VI. and VII. This steel No. 73J showed an extremely fine crystalline fracture, about 20 per cent. being finely granular. The ball hardness of about 217 was obtained whether in its original condition (725 deg. Cent. furnace) or in its heat-treated condition (heated to about 1100 deg. Cent., cooled in air, then reheated to 810 deg. Cent. and cooled slowly in furnace).

I have specially devoted considerable attention to this particular steel, because it illustrates in a clear and decisive manner the very great importance of the influence of carbon in determining hardness.

The work carried out by Abel, Müller, Arnold, and others, with regard to the forms of carbon existing in steel created a great impression upon me, and it is largely their conclusions which have made me a carbonist rather than an allotropist.

*The Great Work of Ledebur.*—The late lamented Dr. A. Ledebur, of Freiburg, cast more light upon this dark place in metallurgy, namely, the relationship of iron and carbon, than anyone with whom I have been acquainted.

*Allotropic Theory.*—As you are all aware, bearing in view the papers quite recently read before the Iron and Steel Institute, it appears to me to have now been clearly proved that, as strongly indicated by my own earlier work many years ago, and by that of other experimentalists, including those to whom I have just referred, there is no such form of iron as an adamantine "beta" form. It is important that this should be made widely known, because now the allotropic theory has been shown to be untenable, more attention will be devoted to other research—for example, in the direction of more fully determining the part played by carbon in that marvellous transition of the steel in its present extreme softness to great hardness—that is, from, say, about 100 Brinell ball number to 600, 700, or even 800, met with when we heat high carbon or other suitable steel to a sufficient degree and water-quench or otherwise suddenly or quickly cool it.

*Thermal Treatment.*—Whilst there are still left elements to be alloyed with iron, and upon which there is ample field for investigation and research, we are, so to speak, nearing the top of the hill. It cannot be very long, unless new elements are discovered, which is not probable, before we shall be able to say that there is little or no more room for discovering new alloys or combinations, and that attention will then have to be turned still more closely than even now to the effect of thermal treatment. This may quite possibly imply treatment at lower grades of temperature than those which we now imply by the term "heat treatment," which leads me to make the following remarks.

*Low Temperature Experiments in Great Britain and America.*—The recent prosecution of research in the direction first dealt with by our great scientist, Sir James Dewar, that is, the behaviour of metals and their alloys at temperatures approaching absolute zero, shows that there is much to be learned from an examination of the physical properties and behaviour of metals and their alloys at such temperatures.

In the joint research carried out by Sir James Dewar and myself, a full description of which will be found in my paper on "Experiments Relating to the Effect of Mechanical and other Properties of Iron and its Alloys Produced by Liquid Air Temperatures," read before the Iron and Steel Institute in September, 1905, it was shown that great increase of tensile strength in steel alloys could be obtained ; in one case a tensile strength of over 150 tons per square inch was obtained, not merely from a wire, but from a forged bar.

Recent experiments in America show that at a temperature of about minus 435 deg. Fah., or close upon absolute zero, metals lose their resistance to such a remarkable degree that the energy developed at the power-house of Niagara, so it is stated, could be transmitted over a quite small metallic wire, simply because resistance vanishes at these temperatures. It will therefore be seen that there is good ground for my statement that before long we may have to consider not merely heat treatment effects, that is, an increase over normal temperature, but also treatments below normal temperature.

*Field for Research.*—It will be seen that even to-day the field for research has been and still is an immense one ; it is full of difficulties and perplexities. Contradictions often seem to present themselves. Nevertheless, the advance made in this branch of alloy steels since the date of my first researches in 1882 and onwards, also my paper on "Manganese Steel" in 1888, has been of startling nature.

Whilst it is true there may not be at the present time room for such abnormal discoveries in ferrous metallurgy as in the past, yet workers all over the world are quietly and steadily adding to our stock of knowledge on points, some of which may not seem so important at the time, but all of which tend to enable us to better understand, and therefore control, the desired qualities of iron and its alloys.

## FORTHCOMING ENGAGEMENTS.

### TO-DAY.

PHYSICAL SOCIETY OF LONDON.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. "On Atmospheric Refraction and its Bearing on the Transmission of Electromagnetic Waves round the Earth's Surface," by Professor J. A. Fleming, F.R.S. ; "Atmospheric Electricity Observations made at Kew Observatory," by Mr. Gordon Dobson ; "Thermal and Electrical Conductivities of some of the Rarer Metals and Alloys," by Mr. T. Barratt ; "On the Measurement of the Temperature Coefficient of Young's Modulus for Metallic Wires with Special Application to Nickel," by Professor E. P. Harrison ; "Some Investigations on the Arc as a Generator of High-frequency Oscillations," by Mr. F. Mercer. At 5 p.m. Editing Committee meeting at 4 p.m. Council meeting at 4.15 p.m.

### THURSDAY, JULY 2ND.

THE INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. The annual conversazione will be held at the Institution from 8.30 to 11.30 o'clock.

### FRIDAY AND SATURDAY, JULY 3RD AND 4TH.

THE INSTITUTION OF MUNICIPAL ENGINEERS.—North-Western District meeting. Friday : General Council meeting, tea and social meeting to be held at the Mitre Hotel, Manchester. Saturday : Visit to the Ashton-under-Lyne, Stalybridge and Dukinfield waterworks.

### TUESDAY TO FRIDAY, JULY 7TH TO 10TH.

INSTITUTION OF NAVAL ARCHITECTS, INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND, NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Joint summer meeting in Newcastle-upon-Tyne. For particulars see page 713.

INSTITUTION OF MECHANICAL ENGINEERS.—Summer Meeting in Paris.

### WEDNESDAY, JULY 8TH.

DIESEL ENGINE USERS' ASSOCIATION.—At the Institution of Electrical Engineers, Victoria Embankment, W.C. 4 p.m. There will be no meeting of the Association in the month of August.

## THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

### New Demands by Operative Engineers.

THE operative engineers in the Birmingham district have formulated new and large wages demands, and there is some fear this week that a wages crisis may arise. The operatives have presented an application for an increase of no less than 5s. per week. The demand is understood to be based mainly on what the men term the increased cost of living, and also on the circumstance that when three years since they made an application for an advance in wages of 2s. a week they accepted a compromise of 1s. per week increase. In addition to the engineers proper, the demand also includes a large number of the members of the Allied Trades Federation, such as toolmakers, steam engine makers, electrical workers, hot water engineers, and a certain section of the brassworkers who are engaged in accessory work in the engineering shops involved in the present wages movement. At present the wages of the operatives in the Birmingham engineering trades is 38s. for men over twenty-three years of age, and the hours worked vary from forty-eight to fifty-three per week. The current wage is somewhat similar in the allied trades, though there full payment commences at twenty-one years of age. All the big engineering shops in Birmingham and the district are concerned in the present demand. Several of these firms each employ from 2000 to 4000 skilled workers, and the men's unions state that something like 30,000 operatives are concerned in the application. It is understood that the Employers' Executive Committee have met to consider the men's demand, but that they consider it inopportune, having regard to the fact that trade is much quieter now than during the recent trade boom. Further developments are awaited with considerable interest.

### Finished Iron Market.

Midsummer day has been left behind, yet the finished iron market remains in a very unfortunate condition. The demand is as bad as it can well be, the works are only running half time, and the prevailing dulness is emphasised by comparison with the well-sustained midsummer activity of recent years. Unmarked bars are quoted at £6 10s., delivered Birmingham, but some firms would accept £6 7s. 6d. for a good specification. Makers of marked bars at £8 10s. are better off for orders than makers of common bars, but there is no pressure in this department. North Staffordshire and Lancashire crown bars can be bought at £7, delivered Liverpool, for the shipping trade. Good second class South Staffordshire bars command £6 5s. to £6 7s. 6d. at works. Nut and bolt qualities make £6 2s. 6d. to £6 5s., delivered Darlaston, rates at which local makers are holding their own against the £5 6s. to £5 8s. quoted by Belgian agents for No. 3 iron. The strip trade is very sluggish. Quotations are on the basis of £6 2s. 6d. and £6 5s. delivered in the district. Steel strip and hoops vary according to thickness and quality from £6 5s. to £7 delivered in the district.

### Corrugated and Plain Sheet Trade.

Despite the measures taken by the Combination in this industry to restrict output, values in the galvanised corrugated sheet trade are hardly remunerative, and some of the leading houses will not entertain business at the cutting rates by which the market is now dominated. The great proportion of the orders are now taken at £10 12s. 6d. for 24 gauge, f.o.b. Liverpool, the quotation of £10 17s. 6d., which is adhered to in respect of superior makes, being very hesitatingly conceded. Plain black merchant sheets for galvanising are quote £7 7s. to £7 15s. per ton. For the five months of this year to the end of May the quantity of galvanised sheets exported was 331,879 tons, and the value £4,089,099, these figures comparing with 320,070 tons and £4,380,628 in the same portion of last year.

### Raw Iron Market.

Pig iron smelters are adhering to recent rates, and in isolated cases are trying to obtain a small advance. At the same time there is not sufficient demand to absorb the reduced output, and many makers carry large stocks. The recent nominal minimum of 47s. 6d. for Northampton low grade forge iron is now a real minimum. Better qualities of Northamptonshire forge pig iron go up to 49s. The makes of other districts were to-day—Thursday—Birmingham sensibly firmer, but it did not amount to quotable change. South Staffordshire common forge realises 48s. and upwards, while part-mine is worth about 50s. to 51s. per ton. Derbyshire iron was stiff at 50s. 6d. to 51s. 6d. Best all-mine Staffordshire iron was 85s. to 90s. for forge sorts, and 92s. 6d. for foundry sorts.

## NOTES FROM LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

**Pig Iron Still Slow.**

THERE was about the usual attendance on the Iron Exchange on Tuesday, but business in most departments was slow, buyers confining operations to immediate requirements only. Pig iron still neglected, and business of a hand-to-mouth character. Prices generally rule nominal, and sellers appear to be willing to meet buyers liberally where business is possible. There is little new to record in finished iron, steel and steel products, but in copper, whilst there was a weaker tendency, there was little or no quotable change in prices. English tin ingots had an upward tendency, and sheet lead also maintains late rates.

**Quotations.**

Pig iron: Lincolnshire No. 3 foundry, 55s.; Staffordshire, 55s. 6d.; Derbyshire, 56s.; Northamptonshire, 57s.; Middlesbrough, open brands, 60s. to 60s. 8d. Scotch (nominal): Gartsherrie, 66s. 6d. to 67s.; Glengarnock, 65s.; Eglinton, 64s.; Summerlee, 66s. to 66s. 6d., delivered Manchester. West Coast hematite, 64s. 6d. to 65s.: East Coast ditto, 61s., both f.o.t. Delivered Heysham: Gartsherrie, 64s. 6d. to 65s.; Glengarnock, 63s.; Eglinton, 61s.; Summerlee, 64s. to 64s. 6d. Delivered Preston: Gartsherrie, 65s. 6d. to 66s.; Glengarnock, 64s.; Eglinton, 62s. 6d.; Summerlee, 65s. to 65s. 6d. Finished iron: Bars, £7 5s.; hoops, £7 7s. 6d. to £7 12s. 6d.; sheets, £8 7s. 6d. to £8 12s. 6d. Steel: Bars, £6 7s. 6d. to £6 10s.; Lancashire hoops, £7 7s. 6d. to £7 10s.; Staffordshire ditto, £7 17s. 6d. to £8; sheets, £9 to £9 5s.; boiler plates, £7 5s.; plates for tank, girder and bridge work, £6 5s. to £6 10s.; English billets, £4 15s. to £4 17s. 6d.; foreign ditto, £4 5s. to £4 7s. 6d.; cold drawn steel, £9 2s. 6d. to £9 5s. Copper: Sheets, strips, &c., £77 per ton, small lots 10d. per lb.; rods, £75 per ton, small lots 10d. per lb.; tough ingots, £67 10s.; best selected, £68 to £68 10s. per ton. Copper tubes, 9¾d.; solid drawn brass tubes, 7¾d.; brazed brass tubes, 9¼d.; condenser tubes, 8¾d.; condenser plates, 7¼d.; rolled brass, 7d.; brass turning rods, 6¾d.; brass wire, 7¼d.; yellow metal, 7¼d. to 7¼d. per lb. Sheet lead, £24 per ton. English tin ingots, £142 per ton.

**The Lancashire Coal Trade.**

There was again a comparatively small attendance on the Manchester Coal Exchange, but the actual business done was not of large dimensions. Interest centres chiefly on contracts, and in house coal, whilst a few collieries were said to have accepted 3d. to 6d. per ton under last year's figures, the majority, however, showed no giving way, especially for better class qualities, and in most cases it is expected the renewal will be on last year's basis. Contracts for slack and engine fuel appear generally to have been fixed at 6d. to 9d. per ton under last year. Shipping and bunkering coal is extremely slow. Quotations:—Best Lancashire house coal, 17s. 8d. to 18s. 10d.; good medium, 16s. 2d. to 17s.; domestic fuel, 13s. 5d. to 14s. 5d.; screened steam coal, 11s. 6d. to 13s.; slacks, 9s. to 10s. 9d. per ton at the pit.

BARROW-IN-FURNESS, Thursday.

**Hematites.**

Business has been rather fuller in hematite pig iron during the past week, and makers are in receipt of new contracts. Locally, there is a full demand for iron, and steel makers at Barrow and at Workington are likely to continue to be considerable users for some time to come. Makers are holding some pretty good orders, and are still sold forward to some extent. The whole of the make is going into immediate use and there is no inclination to cut down the output, there being twenty-two furnaces in blast in the district. It is not considered that the new spurt will be lasting, it being thought that it is just a spurt for the time being only; still, any increase in the demand for iron is welcome. Prices are unchanged, and makers are quoting 66s. to 67s. per ton net f.o.b. for parcels of mixed numbers of Bessemer iron. For special brands there is a steady demand at 72s. to 74s. per ton. There is nothing being done in warrant iron, which is quoted at 61s. per ton net cash.

**Iron Ore.**

The iron ore trade is well employed throughout the district, and raisers are experiencing a full demand on local as well as general home account. The shipments from Cumberland ports to Scotland are considerable, and a fair tonnage is being sent away from Barrow also to Scotland and Dee ports. Prices are about the same, with good average qualities quoted at 13s. 6d. to 15s. 6d., and the best ores are up to 20s. 6d. per ton net at mines. Spanish ores are in steady request at 16s. to 17s. per ton delivered to West Coast furnaces.

**Steel.**

There is activity to report in most branches of the steel trade. At Barrow the rail mills are busily employed, and one of the plate mills is at work, a good tonnage of finished steel being turned out. Rails are being sent away from Barrow to the Mersey for re-shipment overseas and deliveries are being made to home railways. The hood and wire works at Barrow are busy. In Cumberland a good output of steel rails from the Moss Bay Works is being maintained, and some of the other departments are also busy. New business is fairly plentiful. Rails of heavy section are quoted at £5 17s. 6d. to £6 2s. 6d. per ton, and are in steady request. For steel shipbuilding material there is a good steady call alike on local and general home account. Ship plates are at £6 10s. to £6 15s. per ton, with boiler plates at £7 10s. to £7 15s. per ton. The demand for hoops is fairly good at £8 5s. per ton. Nothing is yet being done in tin bars or steel billets.

**Shipbuilding and Engineering.**

Shipbuilders and engineers are as busy as they can be. On the Turkish battleship Reshadieh there is a very busy scene, and effort is being made to get her finished and away from Barrow should she be wanted.

**Fuel.**

There is a steady demand for coal, with good steam sorts at 15s. 6d. to 17s. per ton delivered from either Lancashire or Yorkshire pits. Coke is in full demand at 19s. to 22s. per ton for East Coast sorts, 19s. for Welsh coke and 18s. per ton delivered for Lancashire qualities.

## THE SHEFFIELD DISTRICT.

*(From our own Correspondent.)*

**The Outlook.**

THE brightest feature of the iron and steel industry of the Sheffield district is the enormous amount of work in hand or in prospect at the big armament establishments on home and foreign account. It has been persistently rumoured that the Japanese Government had placed a contract with Vickers, Limited, for another battleship similar to, but larger than, the magnificent vessel which recently left Barrow for the East, but there are good grounds for believing that, although such a vessel has been discussed, the matter has been dropped for the present in consequence of events which have been passing in Japan. But, apart from that, the firm's works here and elsewhere are crowded with orders of one kind and another, including naval work for the British Government, for Spain, Italy, Turkey, Russia, and Japan. Several fine 15in. guns are in course of construction. The other armament firms are almost equally busy, John Brown and Co. being quite as well employed. As regards general trade, things are rather flat, and will, on the whole, remain so now for two or three months perhaps. The undertone, however, appears to be sound, and when considered apart from any comparison with the recent boom periods trade is very little removed from a fairly good normal condition. If things go no worse there will be no harm done until the autumn, when a trade revival should reasonably be anticipated, indications abroad strengthening that opinion. Several large firms are pushing on with works extensions. The armament people are adding large new shops, and other extensions include two electric steel furnaces, one being installed in a new foundry to be run wholly by means of town's gas power. Another new foundry is to be worked on the same principle, and there have been erected an electric rolling mill and several new gas crucible furnaces. Trade with South Africa and Canada is still unsatisfactory, and I understand that three or four firms here have rather heavy stocks of mining tools and implements left on agents' hands in South Africa.

**Round the Works.**

New business secured during the past few days includes a very large amount of Admiralty work on home and foreign account. It is stated that one foreign Power, from which huge contracts have been obtained in the past, has now placed fresh contracts with Sheffield firms for armament and armour plate required over several years, and amounting in the aggregate value to an enormous sum. Heavy tonnages of armour plate have been completed here for Spain, and extensive orders of a similar character from Russia have been booked. Very important work is on hand for the British Government. During the week one firm has been commissioned to construct forward communication tubes for H.M.S. Royal Oak, now being built at Devonport, another firm is to make castings for Chatham Dockyard, and a third has a contract for wood goods required at various naval yards. Heavy engineers are busy, and several tire and rolling mills are being turned out for local firms and for South Wales, while for the latter place good orders have been booked for basic steel melting furnaces and gas producers. The Yorkshire Engine Company are executing a contract for the Hull and Barnsley Railway for five main line locomotives of a heavy type. Other contracts include springs for Port Swettenham, steel for Chemulpo, Delagoa Bay, and Huelva, nuts and bolts for Buenos Aires, wheels for Australia, wagon tires and locomotive parts for Spain, several heavy steel shafts for Australian mines, and for the Madras and Southern Mahratta Railway cutters, hammer blocks, saws, springs, and wheels and axles. The Rotherham Corporation has placed contracts with the British Westinghouse and Electrical Manufacturing Company for a turbo-generator, with the British Thomson-Houston Company for a rotary converter, and with H. Morris, Limited, Loughborough, for overhead equipment.

**Pig Iron, Billets, &c.**

There has been no accession of business in the pig iron markets since my previous report, buying, generally speaking, being limited to quite small parcels for immediate requirements. However, stocks are being kept low at makers' yards, so that whenever there comes a revival in demand makers will probably consider their position such as to justify a strengthening of quotations. At present the tendency is rather the reverse, and, of course, the cheapness of coke is a factor telling in favour of makers. Lincolnshire official prices, with the exception of foundry, which is slightly lower, keep the same as previously reported, though there is a tacit understanding in the Association that where business is offered and members desire to close they are at liberty to do so at rather less than official rates. Even with that advantage, however, consumers maintain their policy of holding off the market as much as possible. Meantime contracts are running out, and, whilst it is stated that 75 per cent. of the Lincolnshire furnaces are in blast, that number is likely to be reduced unless things improve very shortly. There is not much foundry iron from that district used in Sheffield, but the official price is 53s. 8d., with 1s. less for forge and 55s. 8d. for basic. Derbyshire is quoted much below at 50s. for forge and 53s. for foundry. Just recently there has been a considerable easing in hematite values. Ordinary West Coast makes are 72s. 6d. to 73s., and East Coast mixed numbers have been done as low as 66s. 6d., with the general figure about 1s. higher, delivered Sheffield. Billet makers are still having to look out for business, but with a few exceptions prices keep about as follows:—Siemens acid, £6 15s. to £7; and Bessemer acids, £6 10s. to £6 15s., for ordinary qualities; hard basic, £5 10s.; and soft, 5s. less. In face of continued competition from the Continent, however, there is no doubt lower prices are being accepted for good business. Crown bars are £7 5s., with comparatively little being done, and hoops keep at £7 12s. 6d. Scrap iron is quiet.

**Fuels.**

Steam coals show no tendency to relax the firmness developed since the strike in Yorkshire, and with the shipping season in full swing at a steadily improving tonnage it is not likely that values will be easier for some time to come. The industrial demand has shown no decline during the week, though it is chiefly being maintained by the heavy trades. A normal volume of business is going forward in the gas coal section of the market, though little appears to be done in the way of contracts. Collieries are rather stiffening their backs against the price concessions consumers are seeking to obtain, though where stocks are growing special lots are occasionally offered at prices which seem to be nearer buyers' ideas. Best South Yorkshire hards are being sold at 11s. 3d. to 11s. 6d. pit, and best Derbyshire 10s. 6d. to 10s. 9d. Secondary sorts are about 9s. 6d. to 10s. Except for the better sorts, slacks are rather slow and weaker, best hards being quoted 6s. 3d. to 6s. 9d., and steam cobbles 9s. 3d. to 9s. 9d. Coke shows no hardening tendency, the supply still exceeding the demand. Patent coke is quoted at 10s. to 10s. 6d., and best beehive 10s. 6d. to 11s., but patent has been done, for special lots, at less than 10s. at the furnaces.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

**Cleveland Iron Trade.**

THE position in the Cleveland pig iron trade seems to become more difficult than ever to gauge. Opinions in inner circles differ so very much as to what the present evidence of falling away really means. Some ironmasters are very pessimistic, while others are inclined to take an entirely optimistic view of the outlook. The market still continues dull and lifeless, business being restricted to the fulfilment of immediate requirements. Purchasing for autumn shipment does not usually commence until the end of July, and in the meantime the forward position is almost entirely neglected. Moreover, if consumers are holding off, most of the makers are equally reluctant to do business on the basis of current quotations, which are certainly unprofitable, and doubtless this attitude of the makers has tended to accentuate the prevailing slackness. It is a noteworthy fact that, apart from the fall in hematite values, the continued apathy of the market has produced no weakening in the price of Cleveland iron. The output is short of requirements, as is evidenced by the frequent large withdrawals of iron from the public warrant stores, and if the present restriction of the output is continued by the makers it seems to be pretty certain that any substantial buying will inevitably send up prices. There is as yet no definite news concerning the amount of the rebate in the Russian import duty on pig iron. The Russian authorities are fixing a scale which will equalise the advantage of the remission as between the works on the seaboard and those in the interior. This week, owing to a temporary check in the supplies of ironstone, due to the weather, and also on account of the race-week holidays on Tyneside, the three furnaces in operation at Jarrow have been damped down, so that at the present time the total number of furnaces in blast in the North-East of England has been reduced to as low as seventy-one, a number unprecedented during recent years. The three Jarrow furnaces, however, will be in operation again next week. No. 3 G.M.B. Cleveland pig is 51s. 6d.; No. 1, 54s.; No. 4 foundry, 51s. 3d.; No. 4 forge, 50s. 9d.; and mottled and white iron, each 50s. 3d., all for either early or forward delivery.

**Hematite Pig Iron.**

There is no change of moment to note in the condition of things in the East Coast hematite pig iron trade, except a further slight drop in values. The demand is exceptionally slack, for consumers are still showing little inclination to place orders for metal except for small tonnages to cover their immediate requirements. There is no desire to place orders for future delivery even at the lower rates that have been ruling. Indeed, the slackness has become so pronounced that makers are talking about further curtailing the output. Mixed numbers of East Coast hematite pig iron are being freely offered at 59s. 6d. for practically any delivery, and under special circumstances have, in fact, been sold below that figure.

**Iron-making Materials.**

There has been little or nothing done in foreign ore for some weeks past. Merchants still quote on the basis of 17s. 6d. per ton for best Rubio ore of 50 per cent. quality ex ship Tees, but that figure might possibly be reduced for suitable business. Notwithstanding the fact that supplies are more plentiful, the coke position remains very firm. For good medium furnace kinds delivered at the works 17s. 6d. is still the current quotation.

**Manufactured Iron and Steel.**

The outlook in the manufactured iron and steel trades is not at all encouraging. Specifications are still very scarce and short time is being worked at several mills. The finished iron trade is very quiet and orders are not coming to hand in sufficient quantity to keep the works employed to anything approaching full productive capacity. The reduced prices of steel ship plates and angles have not so far occasioned any expansion in the volume of business. The rail trade continues to be active. This week the Cargo Fleet Iron Company has secured an order for 4000 tons of heavy rails for South Australia. The following are the principal market quotations:—Common iron bars, £7; best bars, £7 7s. 6d.; best best bars, £7 15s.; packing iron, £5 15s.; iron ship angles, £7; iron engineering angles, £7; iron ship plates, £6 15s.; iron girder plates, £7 5s.; iron ship and girder rivets, £7 5s.; steel bars, basic, £6 5s.; steel bars, Siemens, £6 5s.; steel ship angles, £5 15s.; steel ship plates, £6; steel boiler plates, £7; steel engineering angles, £5 17s. 6d.; steel sheets, singles, £8 5s.; steel sheets, doubles, £8 10s.; steel joists, £6 12s. 6d.; steel hoops, £6 10s.; steel strip, £6 5s., all less the usual 2½ per cent. f.o.t. Heavy steel rails, £6; steel railway sleepers, £7 5s.; light iron rails, £7, all net at works. Cast iron chairs, £4 5s.; cast iron columns, plain, £7 7s. 6d.; floor plates, £3 10s., f.o.r. at makers' works. There has been no improvement in the demand for galvanised sheets, which are quoted at £11 to £11 5s. per ton of 24 gauge, less the usual 4 per cent.

**Shipbuilding and Engineering.**

There is industrial quietness this week in the shipbuilding trade on the Tyne, the yards being closed down on account of the annual race-week holidays. It is reported that inquiries have been made on Tyneside by the Admiralty regarding the building of a number of torpedo-boat destroyers for this year's programme. It is understood that practically all the Tyneside shipbuilding yards will be tendering for the work. There is little new to report concerning the engineering trades. At present little new business is in evidence, but the works are well employed and some good orders are held.

**Coal and Coke.**

The holidays on Tyneside have produced the usual dislocation of business in the coal market. Merchants have covered their commitments for this month, and are not keen to operate ahead. On the other hand, collieries report fully sold out and are not pressing supplies on the market either for prompt or forward positions. In the gas coal market demand is exceptionally light, but in the absence of transactions prices rule unchanged. Best Durham gas coal is 13s., with secondary at 12s. Bunker coals move slowly and values are barely maintained. The general quotation for best Durham bunkers is 13s. 6d. and for ordinary qualities 12s. 3d. Best Blyths are 14s. to 14s. 4d.; ordinary Blyths, 12s.; and households, 15s. to 16s. Coking fuel and coke dull and weakly held. Foundry coke is 19s. to 20s.; furnace coke, 17s. 6d.; and gas coke, 13s.

## NOTES FROM SCOTLAND.

*(From our own Correspondent.)*

**Pig Iron.**

THE Scotch pig iron trade is extremely dull, and makers generally cannot avoid increasing their stocks. Both the home and export demand for ordinary qualities is very meagre, and prices show a weakening tendency. Scotch hematite has been offered at 62s. per ton and under without bringing out any addition to the volume of business. The number of furnaces in blast in Scotland is seventy-two, the same as in the preceding week and thirteen less than in the corresponding week of 1913. The imports of pig iron into Grangemouth from Middlesbrough and district amounted to 7943 tons for the week.

**Quotations.**

Prices remain on the same level as last week, and are as follows:—Monkland is quoted f.a.s. at Glasgow, No. 1, 61s. 6d.; No. 3, 60s.; Govan, No. 1, 61s.; No. 3, 60s.; Carnbroe, No. 1, 65s. 6d.; No. 3, 61s. 6d.; Clyde, No. 1, 67s.; No. 3, 62s.; Gartsherrie, Summerlee, Calder and Langloan, Nos. 1, 67s. 6d.; Nos. 3, 62s. 6d.; Glengarnock, at Ardrossan, No. 1, 70s.; No. 3, 65s.; Eglinton, at Ardrossan or Troon, No. 1, 61s.; No. 3, 60s.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 60s.; Shotts, at Leith, No. 1, 67s. 6d.; No. 3, 62s. 6d.; Carron, at Grangemouth, No. 1, 68s.; No. 3, 63s. per ton.

**The Warrant Market.**

The volume of business transacted on the Glasgow pig iron warrant market during the past week was the lowest for a complete week for a considerable time past. Several sessions went past without a single transaction being recorded, and the total amount of business done throughout the week was only 3500 tons. Under the circumstances quotations are unchanged, Cleveland iron closing at 51s. 2d. per ton cash buyers, the same

as in the preceding week. Warrant stores have been reduced by 3187 tons during the week, and now stand at 81,598 tons.

**Finished Iron and Steel.**

Steel makers report that in spite of the continued scarcity of specifications for plates and angles, employment at the mills is fairly regular. Makers are only accepting orders for immediate delivery, as they are of the opinion that prices have reached the minimum. There is only a limited demand for steel material for shipment, but notwithstanding the low prices quoted by continental makers, British steel is having the preference in many cases. Black and galvanised sheet makers are coming under the influence of the general depression, and both branches of the trade could do with more orders. The state of affairs in the malleable iron trade is worse than ever, and the combination have found it necessary to close another of its works, and there are now only nine in operation out of the fourteen which they control. Quietness in the consuming trades is responsible in a measure for the dearth of business, but the position is largely the outcome of the importation of foreign competitive material, and until there is a substantial decrease with regard to the latter, little improvement on the present condition of things can be looked for.

**Malleable Iron Prices.**

The West of Scotland malleable iron makers have fixed a minimum selling price for steel bars manufactured from foreign billets of £5 12s. 6d. per ton net for the home trade, but export prices are still uncontrolled by the Association. Makers are endeavouring to come to an arrangement to pool orders on a fixed basis, and in the meantime are giving a scheme a three months' trial, which will terminate at the end of August.

**The Coal Trade.**

The Scotch coal trade on the whole has been fairly satisfactory during the week. Shipments show a good increase, the aggregate clearance amounting to 345,148 tons, compared with 327,904 tons last week and 313,260 tons in the corresponding week of last year. Ell coals are moderately busy, and some fair quantities of the best quality have been booked for shipment towards the end of this month. Best splints are still active, but are not quite so strong as formerly, and supplies are now available within the next few days. Business in navigations is well maintained, but ordinary steams continue in an unsatisfactory position. In smalls, treble nuts are much the same as in the preceding week, but doubles and singles are in better demand at firm rates. Ell coals are quoted f.o.b. at Glasgow, 11s. to 11s. 3d.; splint, 10s. 6d. to 14s.; navigation, 14s. 6d. to 14s. 9d.; steam, 10s. 6d. to 12s. 6d.; trebles, 11s. 3d. to 11s. 6d.; doubles, 10s. 6d. to 10s. 9d.; and singles, 9s. 9d. to 10s. 3d. per ton.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

**Cardiff Coal Trade.**

As usual, when a strike is prevalent, Cardiff is the chief storm centre in South Wales, and now that the marine engineers strike is in progress business is being interrupted, and is likely to be considerably more affected as the withdrawal of the engineers' labour becomes more extensive and the full force of the strike is felt. Each succeeding day makes more acute the difficulty of transacting business. The uncertainty as to the ultimate extent of the strike is checking operations in all directions and, even assuming that negotiations between the engineering societies and the Shipping Federation are entered into, and a settlement arrived at at an early date, damage has been inflicted upon trade from which it will be difficult to recover for some weeks. Tonnage is being held up, both as regards vessels loaded and ready for sea and boats undergoing repair in dry dock. Fitters in the repairing yards are in sympathy with the sea-going engineers and are declining to work on vessels the owners of which refuse to give an undertaking to grant the increased wages to engineers when the vessels are ready for employment, and by the end of this week or even before it is not at all improbable from the trend of events at the time of writing that all work in the ship repairing yards will be at a standstill. So far all Cardiff owners are determined not to concede the men's demands, especially as the Shipping Federation are indemnifying owners for loss incurred in cases of boats actually held up. Tonnage arrived over last week-end far better than was generally expected, and the supply was sufficient to keep the docks occupied for several days. Owing to the risk entailed in chartering British owners, merchants are chiefly inquiring for foreign-owned boats, inasmuch as there is reasonable prospect of these boats fulfilling their charters. But foreign-owned tonnage is scarce, especially as 150 or more boats are locked up in Italian ports. Rates have gone up, but to some extent the fall in the prices of prompt supplies of coal makes up for this. Collieries are gradually getting into difficulties for the want of ready tonnage and new business, and sellers, although not reducing their prices for forward shipping, are daily more prepared to accept lower prices for the shipment of coals in order to secure empty wagons to enable the collieries to continue working. What exactly values are it is difficult to say, as business for prompt loading is a matter of negotiation and governed by individual circumstances. Coals have lost all their relative proportions, and while one firm may have a good supply of foreign boats on stem, others are not so fortunately placed, and consequently have to reduce their prices to any buyer who can tip immediately. Every grade of coal from the best to inferior descriptions is irregular, the only exception being small coals, which have so far shown a very steady tone. Values of large coals, however, are nominal only. The order for 22,000 tons of Admiralty coals for the German navy while cruising in Norwegian waters has gone to Westphalia on account of the relatively high prices in South Wales. It was never really expected that the business would come to this district.

**Nominal Quotations.**

Steam coal: Best Admiralty large, 19s. to 20s.; best seconds, 18s. to 18s. 6d.; seconds, 17s. 3d. to 17s. 9d.; ordinaries 16s. 9d. to 17s.; best drys, 18s. to 19s.; ordinary drys, 15s. 6d. to 16s.; best bunker smalls, 10s. 6d. to 11s.; best ordinaries, 9s. 9d. to 10s. 3d.; cargo smalls, 8s. to 8s. 9d.; inferiors, 7s. to 7s. 9d.; washed smalls, 12s. to 12s. 6d.; best Monmouthshire black vein large, 17s. 6d. to 18s.; ordinary Western Valleys, 16s. 3d. to 16s. 6d.; best Eastern Valleys, 16s. to 16s. 3d.; seconds Eastern Valleys, 15s. 3d. to 15s. 9d. Bituminous coal: Best households, 19s. to 20s.; good households, 17s. to 19s.; No. 3 Rhondda large, 17s. to 17s. 6d.; smalls, 11s. to 12s.; No. 2 Rhondda large, 12s. 3d. to 12s. 6d.; through, 11s. to 11s. 6d.; smalls, 8s. 6d. to 8s. 9d.; best washed nuts, 15s. to 15s. 6d.; seconds, 13s. 6d. to 13s. 9d.; best washed peas, 14s. 3d. to 14s. 6d.; seconds, 12s. 9d. to 13s. 3d. Patent fuel, 19s. to 21s. 6d. Coke: Special foundry, 29s. to 30s.; good foundry, 22s. to 25s.; furnace, 17s. to 19s. Pitwood, ex ship, 19s. to 19s. 3d.

**Newport (Mon.).**

Business in Monmouthshire coals has been substantially curtailed owing to the strike of marine engineers. Buyers, in view of the uncertainty, prefer to hold off as far as possible. Tonnage supplies being short, an easy tone is shown by the market for practically all classes, and it is difficult to ascertain values exactly, as the market is so irregular. Approximate prices:—Steam coal: Best Newport black vein large, 17s. 3d. to 17s. 9d.; Western Valleys, 16s. to 16s. 3d.; Eastern Valleys, 15s. 9d. to 16s.; other sorts, 15s. 3d. to 15s. 6d.; best smalls, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s. Bituminous coal: Best house, 18s. to 19s.; seconds, 16s. 6d. to 17s. 6d. Patent fuel, 19s. 6d. to 20s. Pitwood, ex ship, 19s. to 19s. 6d.

**Swansea.**

During the past week the market in anthracite coals has shown a tendency slightly more in favour of buyers as the result of the disappointing arrivals of tonnage and the inquiry being very slow for early delivery. Anthracite large and machine-made coals have not moved very much in actual values, but rubbly culm is not so firm as a few days ago, and duff failed to command recent figures. Steam coals are quiet all round, but smalls are steady. Anthracite: Best malting large, 21s. 6d. to 23s. net; second malting large, 17s. 6d. to 18s. 9d. net; big vein large, 15s. 3d. to 16s. 3d., less 2½ per cent.; red vein large, 12s. 9d. to 13s. 6d., less 2½ per cent.; machine-made cobbles, 21s. to 22s. 6d. net; French nuts, 21s. 9d. to 23s. 9d. net; German nuts, 21s. 9d. to 23s. 6d. net; beans, 16s. 3d. to 18s. net; machine-made large peas, 12s. to 13s. 3d. net; rubbly culm, 6s. 6d. to 6s. 9d., less 2½ per cent.; duff, 4s. to 4s. 6d. net. Steam coal: Best large, 18s. 9d. to 21s. 9d., less 2½ per cent.; seconds, 14s. 6d. to 15s. 6d., less 2½ per cent.; bunkers, 10s. 9d. to 11s. 6d., less 2½ per cent.; smalls, 8s. 3d. to 9s. 3d., less 2½ per cent. Bituminous coal: No. 3 Rhondda large, 17s. to 18s., less 2½ per cent.; through and through, 14s. to 15s., less 2½ per cent.; smalls, 11s. to 11s. 9d., less 2½ per cent. Patent fuel, 17s. to 17s. 6d., less 2½ per cent.

**Iron and Steel Trades.**

Pig iron: Standard iron, 50s. 10½d. cash, 51s. month; hematite mixed numbers, 61s. cash, 61s. 1½d. month; Middlesbrough, 51s. 3d. cash, 51s. 5d. month; Scotch, 57s. 3d. cash, 57s. 4½d. month; Welsh hematite, 65s. dd.; East Coast hematite, 65s. c.i.f.; West Coast hematite, 66s. to 67s. c.i.f. Steel bars: Siemens, £4 11s. 3d. per ton; Bessemer, £4 10s. per ton; steel rails, heavy sections, £6 2s. 6d. per ton. Iron ore: Rubio, 17s. to 17s. 3d.

**Tin-plate and other Quotations.**

I.C., 20 × 14 × 112 sheets, 12s. 1½d.; I.C., 28 × 20 × 56 sheets, 12s. 4½d.; I.C., 28 × 20 × 112 sheets, 24s. 3d.; I.C. ternes, 28 × 20 × 112 sheets, 22s. to 22s. 6d.; finished black plates, £9 10s. per ton; galvanised sheets, 24 g., £10 15s. to £11 per ton. Block tin, £138 17s. 6d. per ton cash, £140 12s. 6d. per ton three months. Copper, £61 2s. 6d. per ton cash, £61 13s. 9d. per ton three months. Lead: English, £19 17s. 6d. per ton; Spanish, £19 12s. 6d. per ton. Spelter, £21 7s. 6d. per ton. Silver, 2s. 2d. per ounce.

## AMERICAN NOTES.

*(From our own Correspondent.)*

NEW YORK, June 10th.

ABSOLUTE necessities are now forcing several railway systems into the market for cars, bridge material, and rails. Unfilled orders of the Steel Corporation, May 31st, were about 3,900,000 tons, against 4,277,068 tons, April 30th. Car orders for the past week were for 11,500, calling for 130,000 tons plates, which orders are now in process of being placed. General structural orders just reported for week, 35,000 tons, made up of numerous small orders. The new specifications for steel rails are very exacting. Bridge building demands are of greater magnitude. Orders for railroad bridges for week all over the country call for 90,000 tons shapes. This business has given tone to the market, but with practically half the mill capacity idle it will take several such weeks to put the industry on strong legs. Furnace output declined from 70,591 tons on May 1st to 64,514 tons June 1st. Big transactions have been closed at Southern furnaces, reaching, it is reported to-day, close to 100,000 tons, of which about one-half are for export on a basis of 10.25 dols. Birmingham, Ala., for No. 2, for Australian and Mediterranean ports. Heavy May sales of basic have checked further concessions. Furnace and mill interests are too hungry to increase capacity to make stronger prices at present possible. Low-grade iron is very active. Pipe works are crowded for the most part. Bar mills are dull. Merchant steel moves slowly. Two shiploads of ore from Chili arrived at Philadelphia, and as soon as possible a large fleet will be engaged in that service to supply the Bethlehem mills. Copper production for April 115,900,000 lb., or 11,425,725 lb. over same month last year. For four months 448,423,784 lb., an increase of 38,059,890 lb. over same four months last year. For May surplus stock increased 14,005,640 lb. Domestic consumption decreased 7,800,000 lb. Exports decreased 9,600,000 lb. The Westinghouse strike at Pittsburgh took an inquiry for 1,000,000 lb. out of the market.

NEW YORK, June 17th.

IRON and steel conditions show some improvement of a promised permanent character. The Steel Corporation shows new business during May—about 48,000 tons a day, with shipments about 29,000 tons a day. So far in June its new business has averaged 25,000 tons a day. Prosperous agricultural conditions are bringing out the implement makers, who will ask for a blanket contract for about 1,000,000 tons of merchant steel to cover their wants for twelve months from July 1st. Steel makers will probably decline to contract for more than six months' deliveries, owing to low current prices and the probabilities of better prices at the end of that period. The stronger undertone has brought out inquiries for 150,000 tons of structural steel for building purposes in the larger cities. In addition to this aggregate, there are the New York subway contracts and several large bridge building contracts. The long pending Portsmouth bridge order is to be closed on June 20th. Besides the large car building order reported last week, the railroads have this week ordered 720 freight cars, 18 coaches, 13 locomotives, and 22,150 tons rails. The 80,000-ton order for cast iron segments is still in abeyance. Steel making irons are very active. Very recent orders for low-grade iron and pending orders to be closed in a few days foot up the heavy total of 200,000 tons, which will harden the low-grade iron quotations. A larger volume of potential business is held in check for various reasons. Pipe line work is extremely urgent. Fully 800 miles of domestic and foreign pipe line business is being figured on this week. The copper market is quiet. Even the drop of electrolytic to 14 brought out but little business. Exports since June 1st, 14,228 tons; total for year, 224,078 tons. The copper-using trades are doing very little business. The Westinghouse plants are practically tied up with a strike.

## CATALOGUES.

THE JUDSON-JACKSON COMPANY, Limited, 50, Marsham-street, Westminster, S.W.—This company has sent us a copy of its new catalogue on chucks.

A WELL got up pamphlet dealing with Wells' waste oil filters has reached us. The principle of these filters is fully described, and full particulars, such as prices, &c., are given.

FROM Marconi's Wireless Telegraph Company, Limited, of Marconi House, London, W.C., we have received a well got up catalogue on receiving and measuring instruments.

FROM Perman and Co., Limited, 82–83, Fenchurch-street, E.C., we have received a catalogue dealing with "Kromhout" marine oil engines. The engines are described and illustrated.

FROM A. Reyrolle and Co., Limited, Hebburn-on-Tyne, we have received copies of pamphlets Nos. 114 and 144. The former deals with earthed pluga and sockets and the latter quick make and brake oil switches.

"SILVERTOWN Insulators, Fittings, and Tools for Telegraph and Telephone Lines" is the title of a well got up catalogue sent to us by the India-rubber, Gutta-percha and Telegraph Works, 106, Cannon-street, E.C.

ROBERT W. PAUL, New Southgate, London, N.—Mr. Paul has sent us an extensive catalogue on apparatus for temperature measurement in industrial and laboratory process, including thermo-electric resistance and radiation pyrometers, indicating, alarm, and recording.

THE ADNIL ELECTRIC COMPANY, Limited, Adnil-buildings, Artillery-lane, London, E.C.—From this company we have received a catalogue dealing with direct-current dynamos and motors with interpoles. It gives particulars of motors ranging from 4 to 125 horse-power and dynamos from 3½ to 90 kilowatts.

SIEMENS BROTHERS AND CO., Limited, Woolwich.—This company has sent a copy of its new pamphlet A 550, dealing with the quenched spark system of wireless telegraphy for ships, which is now installed on over 100 British vessels. The pamphlet contains much interesting information, and an extract of all the important recommendations regarding wireless telegraphy by the recent Committee for Safety of Life at Sea.

THE A.E.G. COMPANY, Limited, 133–135, Oxford-street, London, W.—"Electricity in the Home and Workshop" is the title of a well got up publication sent to us by this company. It deals with electric lighting with incandescent lamps, electric lighting with arc lamps, electric lighting with quartz lamps, electric heating and cooking apparatus, electric fans, electric motors for household use, electric motors for industrial use, illumination and advertisement lighting, electric Christmas tree lighting, electric clocks.

WE have received from Siemens Brothers and Co., Limited, Woolwich, a copy of their catalogue 519 on "Paper-insulated Cables" and Catalogue 521 on "Cable Joint Boxes." Catalogue 519 contains particulars of paper-insulated cables of various descriptions for working pressures up to 11,000 volts. The cable joint box list is one of the most comprehensive lists we have seen. It gives full descriptive information on feeder pillars, disconnecting fuse and link boxes, sealing ends and end dividing boxes, straight joints, tee and service buxes, house service fuse boxes, crane connection boxes, mining gear, and general accessories.

SANDYCROFT LIMITED, Sandycroft, near Chester.—From this firm we have received a leaflet on the Akron Chilian mill for mining work. This mill, the leaflet states, has been in practical operation for many years, and is in daily use in the mining districts of the United States of America, Mexico, South Africa, and most of the other mining countries of the world. Chilian mills of the high-speed type usually operate on ores which have already been crushed down to a size the maximum of which is about ¼in. cube, but more often the size fed to them will be about ⅛in., and they crush down to almost any fineness required, about 30 or 40 mesh, however, being probably the most usual.

A NEW 200-page catalogue has been sent to us by Wablach Brothers, Limited, of Royal House, Finsbury-square, E.C. It deals with pressure gauges, thermometers and pyrometers, valves, cocks and check valves, water gauge fittings, gauge glasses, ball valves, steam traps, steam whistles, oil economisers, oil filters, oil cans, tube brushes, tube cleaners, chucks, an adjustable lathe face plate, lathes, portable electric drilling machines electric bench drilling machines, universal drilling machines double-geared pillar drilling machines, sensitive drilling machines, grinding machines, hand shaping machines, automatic saw sharpening machines, filing machines, pulley blocks, worm-geared hoists, jacks, overhead travelling trolleys, asbestos and acid-proof safety garments, sand blast helmets, respirators, eye protectors, carboy stands, belt lifting apparatus, fire fittings, fire extinguishers, plaited metallic hose coupling, the "Key" hose reel, garden hose, flexible metallic tubing, interlocking tubing, high-pressure jointing, rubber goods, corrugated metallic joints, packings, plummer blocks, hangers, pulleys, belt fasteners, beltings, driving ropes, files and rasps, spanners, wrenches, tube cutters, pliers, vices, stocks and dies, taps, high-speed twist drills, forges, blow lamps, spray pumps, spraying machines, semi-rotary wing pumps, semi-rotary barrel pumps, suction pumps, centrifugal pumps, double-acting piston pumps, &c.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE London office of the United States Metallic Packing Company, Limited, of Bradford, has been removed to 116, Fenchurch-street, E.C. Telephone number, Avenue 2710.

BRUCE, PEEBLES AND CO., Limited, have appointed Mr. E. W. Browne as their Birmingham office manager in place of Mr. Hilton, who has resigned that position to take up other work. Mr. Browne has been connected with the firm for many years, and is thoroughly familiar with its manufactures.

MR. J. OWDEN O'BRIEN, patent agent, of Manchester, informs us that consequent on the extension of the Manchester Royal Exchange and on the absorption of Bank-street and his office in the scheme, he is compelled, after an occupation of nearly thirty years, to change his address, and that his address is now Lloyd's Bank-buildings, corner King-street and Cross-street, Manchester.

CONTRACTS.—Messrs. S. and C. Bishop and Co., of St. Helens, Lancashire, ask us to announce that the sole use of their "Bishop's Adamant" gauge glasses has been adopted on the Victorian State Railways, Australia, and that a contract has been placed for two years' supply.

SECOND INTERNATIONAL CONGRESS OF CONSULTING ENGINEERS.—As previously announced, the second International Congress of Consulting Engineers—Deuxieme Congrès Internationale des Ingénieurs Conseils—in connection with the Fédération Internationale des Ingénieurs Conseils, will be held at Berne from July 15th to 22nd next. The first meeting of members will be in the Congress Hall of the National Swiss Exhibition, which is being held at Berne this year, and it is called for 10 o'clock on the morning of Wednesday, July 15th. The meeting will be devoted to the reading and discussion of communications made by members. On the Thursday at 10 a.m. there will be another meeting in the Congress Hall of the Exhibition, after which there will be a mid-day banquet and a further business meeting in the afternoon. On the Friday morning there will be a further meeting of members which will be followed by a special meeting of delegates to the Federation for the transaction of business. There will be an excursion to Grosswabern and Gurten in the evening. On the Saturday morning the closing meeting of the Congress will be held, and in the evening the members will leave Berne for Spiez. On Sunday, the 19th, an excursion will be made to the summit of Niesen, after which the members will proceed to Kandergrund where the hydro-electric installation which furnishes the current for working the Lötschberg Railway will be inspected, and an excursion made to the Lac Bleu. Kandersteg will be reached in the evening. On the Monday the party will proceed through the Lötschberg Tunnel to Brigue, where the second Simplon Tunnel works will be inspected. Afterwards a return will be made down the Rhone Valley to Montreux, and the members will proceed by steamer to Ouchy and Lausanne, where the meeting will terminate.

## NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

*(From our own Correspondent.)*

### Rheinland-Westphalia.

THE most important event of the week has been the reduction in the prices for pig iron for sales in next quarter which the Pig Iron Convention has unexpectedly resolved upon. Luxemburg forge pig met with a reduction of M.2.50 p.t., hematite M.2 to M.2.50 p.t., while foundry pig was reduced by M.1 p.t. The number of orders coming in for the different sorts of crude iron is comparatively satisfactory; of course, there is a good deal of competition, both inland and foreign, in this as in all other branches of the iron industry; still, the works have been able to maintain a fair activity up till now. Deliveries for May were about the same as in the previous month, but those for June will probably show a decrease owing to repairing and stock-taking at some establishments. Foreign demand for pig iron has shown a slight improvement this week. Little movement is felt in the semi-finished steel trade, but prices are tolerably stiff. Raw bars stand at M.82.50, billets at M.95 p.t., and plates at M.117.50 p.t. in the Rhenish-Westphalian district. Some important orders for bars have been secured lately. Prices are fluctuating, some mills refusing to do business at less than M.96 to M.98 p.t. with 1½ per cent. discount, while now and then sales at M.94 to M.95 p.t. are being effected. For export M.81 to M.82 p.t. is the price generally quoted at present, which means an improvement of M.1 to M.2 p.t. as compared with previous month. The basis price for iron bars has been reduced to M.138 p.t. for the third quarter. Owing to increasing employment in the sheet department prices were advanced M.2 to M.3 p.t. last week, and some business has been done at M.117.50 to M.120 p.t. Heavy plates remain neglected as before.

### The Iron Market in Silesia.

The condition in the various branches of the iron and steel industry is certainly not very encouraging; still, the mills and factories are kept going pretty regularly. An improvement is expected to set in when an agreement has been arrived at between the various syndicates, but until now the negotiations carried on for that purpose have been without success. In the pipe department the Huldschinsky Works and the Bismark-Hütte have joined in an office for sale. The Donnersmark-Hütte is building a new pipe foundry, the cost of which is estimated at four million marks. Iron ore remains low in price, owing to consumers holding back. Stocks of pig iron continue heavy. The semi-finished steel works are only moderately engaged. The condition of the bar trade is distinctly unsatisfactory, and there is only a very limited business done in girders, though rails have continued in good call at paying prices. The outlook also seems bright in this department. Negotiations are carried on between the State Railways and the Steel Convention concerning supplies in rails and railway material for the next three years. Compared with the last contracts two years ago, prices will be reduced M.4 p.t. for rails and M.4.50 p.t. for iron sleepers, the former standing at M.114 p.t., while for sleepers M.104.50 p.t. will be quoted.

### List Quotations.

The following are the latest prices, per ton, free at works:—Raw spathose iron ore, M.12.10 p.t.; roasted ditto, M.18.50 p.t.; Nassau red iron ore, 50 per cent. content, M.13.50 p.t. net at mines; spiegeleisen, 10 to 12 per cent. grade, M.79 p.t.; white forge pig, Siegerland and Rhenish-Westphalian brands, M.66; iron for steel making, M.69 to M.70; German Bessemer, M.79.50; Luxemburg foundry pig, No. 3, free Luxemburg, M.60 to M.62; German foundry pig, No. 1, M.75.50; the same, No. 3, M.70.50; hematite, M.79.50; good merchant bars in basic, M.94 to M.97; hoops in basic, M.115 to M.120; heavy plates in steel, M.99 to M.102; steel plates, for boilermaking purposes, M.109 to M.112; sheets, M.115 to M.120; drawn wire in iron or steel, M.117.50.

### The German Coal Market.

A weakening tone could be noticed in the Upper Silesian coal-producing district. Exports in particular are limited, and show a tendency to decrease, while home requirements, though regular, are hardly up to the average. The State Railways have signed contracts with the Silesian coal-owners for one year at M.12 p.t. Demand and consumption in Rheinland-Westphalia are satisfactory.

### Austria-Hungary.

The outlook in iron and steel has improved a little. Returns for May show a slight increase in deliveries, especially from Bohemian works, at very low rates however.

### Quiet Trade in Belgium.

A fortnight ago indications of improvement had been noticed in the iron and steel industry, but recently demand and occupation have again been exceedingly slow. Forward sales are quite an exception, and consumers and dealers are disinclined to buy more than is absolutely necessary. Nevertheless prices are a trifle more firm since the slight revival of a few weeks ago, only basic bars having met with a reduction in price. The production in pig iron has been reduced in consequence of slow demand. Of 59 existing blast furnaces 10 have been put out. Production in forge pig in Belgium has been stopped entirely for the present. Semi-finished steel is weak; 69s. to 70s. p.t. for export is being quoted for blooms. An irregular sort of business is being done in plates, some mills being fully occupied, while others can hardly keep up a moderate activity. Heavy plates for export are standing at £4 15s. p.t.; medium sorts realise £4 16s. p.t., while thin plates are offered at £4 18s. p.t. Bar orders continue to come in pretty regularly, but for export a decrease in quotations is reported; £4 1s. p.t. is quoted for basic bars, those in iron realising £4 7s. and £4 8s. p.t., free Antwerp. Inland quotations have remained the same as before, 110f. p.t. being quoted for basic bars and 122.50f. to 125f. p.t. for iron bars. A steady sort of business is transacted in hoops, and the export price of £5 15s. p.t. was well maintained in spite of German competition. Steel castings are poorly inquired for. Until recently both the railway and structural departments had been well occupied; lately, however, an abatement in activity was noticed in the wagon building branch, and the shops are now eagerly awaiting the tenderings for the State Railways when 2600 goods wagons are to be given out.

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ROYAL SOCIETY OF ARTS' MEDALS.—The Council of the Royal Society of Arts has awarded the Society's silver medal to the following readers of papers during the session 1913–1914. At the ordinary meetings: Mr. P. Chalmers Mitchell, F.R.S., "Zoological Gardens"; Mr. John Charles Umney, "Perfumery"; Mr. Arthur Fell, "The Channel Tunnel"; Mr. W. S. Rogers, "The Modern Poster"; Mr. Edward F. Strange, "Japanese Colour Prints"; Mr. William Reginald Ormandy, "Motor Fuels, with Special Reference to Alcohol"; Mr. R. A. Peddie, "Colour Printing"; Mr. E. Halford Ross, "House Flies and Disease"; Mr. John Clarke Hawkshaw, "The Early History of the Channel Tunnel." In the Indian Section: Colonel T. Holbein Hendley, "Indian Museums"; Mrs. Patrick Villiers-Stuart, "Indian Water Gardens"; Mr. George C. Buchanan, "The Port and City of Rangoon"; Sir James M. Douie, "The Punjab Canal Colonies." In the Colonial Section: Sir Robert William Perks, Bart., "The Montreal, Ottawa and Georgi[illegible] Bay Canal."

## BRITISH PATENT SPECIFICATIONS.

*When an invention is communicated from abroad the name and address of the Communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 8d. each.*

*The date first given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete Specification.*

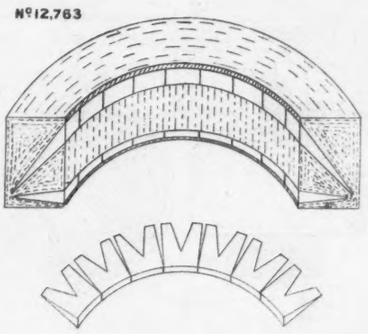
*Any person may, on any of the grounde mentioned in the Act, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of any Patent.*

### STEAM ENGINES.

12,763. June 2nd, 1913.—AN ASBESTOS-METALLIC PACKING FOR STEAM ENGINES, George Herbert Howard, of Holmlea, 13, Walton Hall-avenue, Liverpool.

The packing described in this specification is for packing rods and spindles of steam engines. It consists of a combination of asbestos and white metal, with a wedge action. It is to be made of rectangular-shaped turns of asbestos, woven laid or pressed to the required shape, and having two sections of tapered white metal in contact with the rods or spindles. The upper section of metal is formed of adjoining tapered pieces—as shown in the lower illustration—inserted diagonally across each turn, so that the thick edges bear against the rod or spindle, while the thin edges terminate near the opposite lower corner. The lower section of metal is also composed of adjoining tapered pieces, laid horizontally in the asbestos, near to the bottom,

Nº12,763



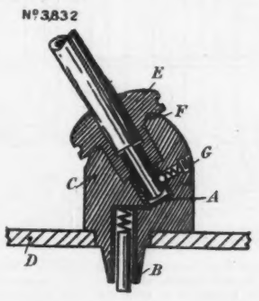
having their thick edges bearing against the rod or spindle and their thin edges terminating near the opposite side of the packing. The upper section of white metal being so laid, ensures a larger and better supply of white metal to take up the wear, than in other makes of asbestos metallic packing. It also assists to force the lower part of the asbestos against the rod or spindle, and by reason of its angle and by the wedge-shaped upper part of the asbestos, will readily lie against the rod or spindle, requiring only a minimum of pressure to keep it there. The lower section of metal is to further increase the metallic surface and to assist the asbestos.—*June 3rd*, 1914.

### INTERNAL COMBUSTION ENGINES.

3832. February 13th, 1914.—BRUSH HOLDER AND PLUG CONTACT FOR USE WITH MAGNETO-ELECTRIC IGNITION APPARATUS, Unterberg and Helmle, of Durlach, Baden, Germany.

B is the carbon brush which takes current from the rotating part of the magneto electrical ignition apparatus. The current is led from the sliding contact B to the casing A of the plug contact which may advantageously be arranged in sloping position in good insulating material C secured to the casing D of the ignition apparatus. The plug of the plug contact consists of the metal conductors and a ring E, which is advantageously

Nº3,832



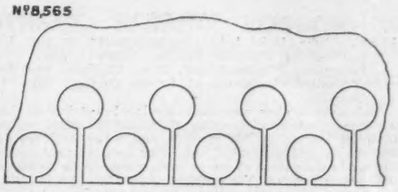

formed of insulating material and has an annular recess in its under face in which the annular projection on the insulation C of the casing of the plug contact can engage. The casing of the plug contact is further provided with the snap locking device G. This snap locking device comprises a spring-pressed ball which is forced into an annular groove in the plug so that the plug is drawn into the casing, with the result that pressure is exerted upon the labyrinth joint between the thimble E and the surface F.—*June 3rd*, 1914.

### DYNAMOS AND MOTORS.

8565. April 4th, 1914.—IMPROVEMENTS IN ALTERNATING ELECTRIC CURRENT MACHINES HAVING BAR WINDING, Allmanna Svenska Elektriska Aktiebolaget, of Westeras, Sweden.

It is very advantageous in alternating electric current machines to use one bar only in each slot, the most important advantages of such arrangement being the following:—There is no risk of series connected bars being short-circuited and therefore insulation against the iron core only is required. Such insulation may consist, for instance, of a tube of paper, micanite or the like. Repairs can be made in a simple and ready manner even in partially or completely closed slots, because the bars together with their insulating tubes can be drawn out of and inserted in the slots from the one end thereof. The coil heads will be well ventilated, simple and strong, the bars being connected by means of copper strips separated by air spaces. The strips can readily be soldered to the ends of the bars or, when necessary, be removed therefrom. According to the present invention, the slots are not, as hitherto, arranged in one row only around and in close proximity to the air gap, but in two or more rows arranged at different distances from the

Nº8,565



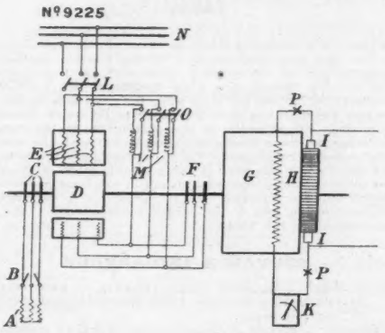
air gap adjacent slots in the different rows being in staggered relation to one another, in order that the desired density in the teeth may not be exceeded. The drawing shows diagrammatically one embodiment of the invention, in which are provided two rows of slots, each slot being adapted for one bar only. The arrangement may be readily understood without any further explanation. There is another illustration.—*June 3rd*, 1914.

### CONVERTERS.

9225. April 14th, 1914.—IMPROVEMENTS IN OR RELATING TO THE STARTING AND SYNCHRONISING OF ROTARY CONVERTERS, Siemens, Schuckertwerke G.m.b.H., of Siemensstadt, near Berlin.

The rotary converter G and the rotor D of the pony motor are mounted on the same shaft. The stator winding E of the pony motor is the inducing winding and the coils M of a three-phase choking coil are connected to the terminals of the stator winding. The combination thus formed is, when the rotary converter is to be started, included in the leads between the mains N and the slip rings F of the converter. A short-circuiting switch O is provided which is closed after synchronising has occurred, and throws the pony motor and choking coils out of action. The converter field winding H is connected in series with a regulating resistance K across its commutator brushes I, a switch diagrammatically indicated by F P being provided for reversing the field connections in case the converter comes into synchronism with the wrong polarity on the direct-current side. The set is started up by closing the switch L. A switch B is provided for short-circuiting the rotor resist-

Nº9225



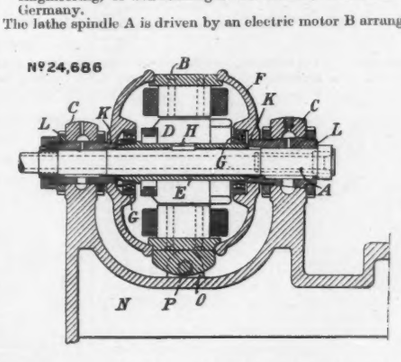

ance A of the pony motor. It will be noted that owing to the presence of the winding E and coils M in the leads to the rotary converter slip rings a suitably reduced pressure can be applied to the converter, thus reducing the rush of current. After the set has come into synchronism the short-circuiting switch O is closed. It is to be understood that the functions of the rotor and stator windings may be reversed: that is to say, the rotor winding may be placed in series between the mains N and the armature of the rotary converter, the stator winding becoming the induced winding. The pony motor may, if directly coupled to converter, have the same number of poles as the converter, in which case the normal slip of the pony motor and the starting current must be so designed that the rotary converter can pull itself into step; or the pony motor may have a smaller number of poles. If transmission gear having a ratio of transmission differing from unity is arranged between the pony motor and the converter, there is a greater range in the choice of the number of poles for the pony motor. The starting arrangement, it should be understood, is not limited to three-phase machines, but may be used with machines having any number of phases.—*June 3rd*, 1914.

### MACHINE TOOLS AND SHOP APPLIANCES.

24,686. May 26th, 1913.—IMPROVEMENTS IN OR RELATING TO THE HEADSTOCKS OF ELECTRICALLY DRIVEN LATHES AND OTHER MACHINE TOOLS, Herbert Kienzle, Doctor of Engineering, of Schwenningen am Neckar, Wurttemberg, Germany.

The lathe spindle A is driven by an electric motor B arranged

Nº24,686




between the spindle bearings formed in the vertical portions C of the headstock. The armature D of the motor is secured to

a sleeve E, which rotates within the motor casing F in ball bearings G, and the rotary movement of the armature and of the sleeve E is transmitted by a key H to the spindle A. The casing F of the motor is supported by extensions K of the bushes or sleeves L which constitute the spindle bearings and the bed N is provided with a lug O, in which are mounted one or more screws P which prevent the motor casing from turning.—*June 3rd*, 1914.

## CABLES.

13,602. June 12th, 1913.—IMPROVEMENTS IN THE MANUFACTURE OF ELECTRIC CABLES, Charles James Beaver, Rangemoor, Crescent-road, Hale, Cheshire, and Ernest Alexander Claremont, of Broom Cottage, High Legh, Cheshire.

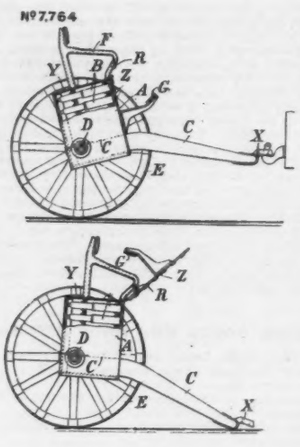
This invention has reference to insulated electric cables having an outer protecting covering of rubber or other compound material having flexible resilient and waterproof properties. On the external surface of the outer covering projections are formed in the nature of one or more spiral ribs or in the nature of studs or nodules. The projections are homogeneous or in one with the outer covering and may be of the same material or some other suitable material having such properties as aforesaid. These projections afford a mechanical protection to the covering of the cable which in some cases are intensified by

toughening or hardening the projections. In the manufacturing of the cable with projections, a forcing machine of the type commonly in use for covering cables with compound is used, and suitably shaped dies with mechanism are used where necessary for moving the same while the cable is being brought through the machine, or it is possible to lay on or attach the projections subsequently to the putting on of the covering rendering the same homogeneous or in one with the covering by a process of vulcanising. The upper drawing is a cross section and the lower a side view showing a cable made according to this invention, the projections being in the form of diamond-shaped studs or nodules. In the drawings A indicates the insulated conductors, B the rubber covering, and C the projections.—*June 3rd*, 1914.

## ORDNANCE AND ARMOUR.

7764. March 27th, 1914.—IMPROVEMENTS IN AND RELATING TO AMMUNITION WAGONS, Fried. Krupp Aktiengesellschaft, of Essen, Germany.

The object of this invention is so to perfect ammunition

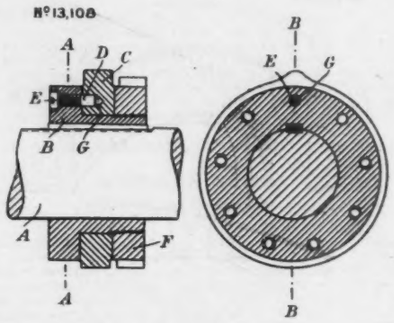



wagons that a special support for the perch is rendered superfluous. The ammunition wagon has a body A for holding cartridges B, and the axle D for the wheels E of which wagon passes through the body A. In the lower part of the wagon body A is fixed the perch C carrying the limber eye X. The upper wall Y of the wagon body serves as a seat for the crew. The wall Z of the wagon body next to the limber eye X, can be turned upwards and is secured in the turned up position by hooks R or the like to the side arms F of the seat. Upon the wall Z is mounted a foot rest G for the crew. The portion of the perch C which protrudes from the wagon body is bent so far downwards that, when the wagon is unlimbered, it can be used directly as a support for the wagon body. The ammunition when the body is so supported then lies nearly horizontal. This construction of the perch, for ammunition wagons in which the ammunition is removed at the side on which the perch is arranged, also affords the advantage that the soldier who takes the ammunition from the wagon body is not obliged to station himself alongside the perch, but by standing with his legs straddled over the perch or by seating himself thereon, can take up his place behind the centre of the wagon body; that is to say, in a well-protected position.—*June 3rd*, 1914.

## MISCELLANEOUS.

13,108. June 5th, 1913.—CAMS, Allgemeine Elektricitäts Gesellschaft, of 2–4, Friedrich Karl Ufer, Berlin, N.W., Germany.

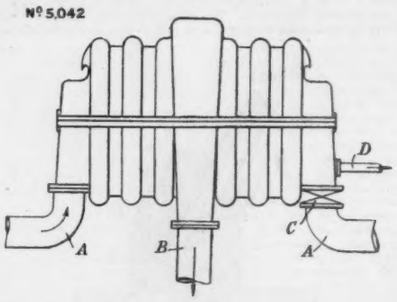
A flanged sleeve B is keyed to the shaft A and serves as a supporting boss for the adjustable cam C arranged upon it adjacent to the flange. The angular position of the cam with reference to the supporting boss is determined by a screw pin E provided with a spindle-like projection D, and is secured by a lock nut F. A large number of recesses, into one of which is inserted the spindle-like projection D of the pin E determining the position of the cam, is arranged in the cam unsymmetrically with a similar series of holes in the supporting boss into any one of which the pin E may be screwed. In the construction shown nine recesses or holes are provided for the respective parts B




and C, and are so arranged on both sides of those indicated G, determining the middle position B–B of the cam, that they gradually register with each other less and less as the distance from this middle position increases, so that the cam can be adjusted from the position B–B to both sides through gradually increasing angles. The adjustment of the cam is effected on the slight loosening of the nut F and the withdrawal of the screw pin E, when the cam C may be turned through the desired angular distance. The screw pin E or connecting member is then inserted in the recess and hole which are in register in the new position of the cam.—*June 3rd*, 1914.

5042. February 26th, 1914.—IMPROVEMENTS IN AND RELATING TO THE OPERATION OF TURBO COMPRESSORS OR PUMPS, Aktiengesellschaft Brown, Boveri and Cie., of Baden, Switzerland.

The object of the present invention is to provide a method whereby a high pressure may be obtained temporarily without involving an increased output, so that it is unnecessary to design the driving engine with abnormal dimensions. The invention consists in increasing the pressure in double-ended turbo compressors by wholly or in part shutting off one half of the com-



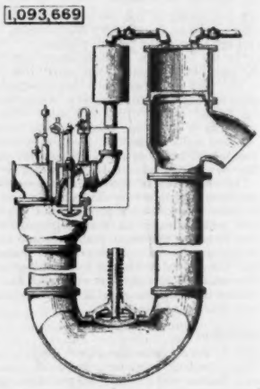

pressor, so that it gives practically no delivery when a temporary increase of pressure is to be obtained. A compressor is provided with a suction branch A at each end and a common delivery B in the middle. A damper C is arranged in the suction conduit A of one half of the compressor—in the present instance, the right half. In operation, when a high pressure is to be attained the damper C is closed. In that case only the other—in the present instance, left—side will remain in operation. The delivery output will be reduced to one half or even to less, and as regards the shut-off end, only the no-load losses occur therein. It is a well-known fact that the pressure of a working turbo compressor is considerably higher than the pressure produced by the same when running idle, that is, under no load. For this reason a pressure above atmospheric pressure, originating from the working half of the compressor, will obtain in the closed suction branch. By opening a branch conduit D, so that a communication is established between the closed suction branch and the atmosphere, it is possible to set up a current or circulation in the closed end or half of the blower in the opposite direction, thus removing the heat generated by running idle. The same advantage can be obtained also without a branch conduit, in cases where two independent suction conduits are used, provided the damper C is not entirely closed, so that the cooling air may flow through the corresponding suction conduit itself and escape into the atmosphere.—*June 3rd*, 1914.

## SELECTED AMERICAN PATENTS.

*(From the United States Patent-office Official Gazette.)*

1,093,669. INTERNAL COMBUSTION PUMP, *C. E. White, San Francisco, and C. H. McIntosh, Berkeley, Cal.—Filed October 4th*, 1912.

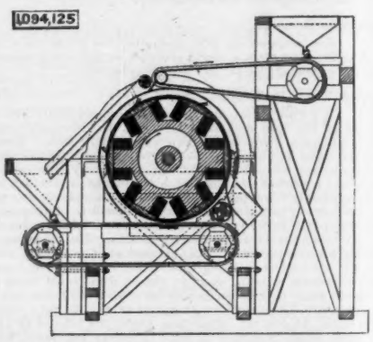
The combustion chamber has a valve-controlled inlet with a delivery pipe connected to it, which also has a valve-controlled liquid inlet. A gas compression chamber is arranged in the upper end of the combustion chamber, and there is a piston within this




gas compression chamber which is adapted to be operated by a liquid piston within the delivery pipe. There are valve-controlled gas supply pipe and a valve-controlled connection, having a receiver, between the gas compression chamber and the combustion chamber. There are nine claims.

1,094,125. MAGNETIC SEPARATOR, *R. W. Cousins, Chicago, Ill.—Filed September 11th*, 1908.

The separator is furnished with a series of electromagnets, which can be rotated. There are means for conveying material into the field of the magnets, whereby the magnetic material is partially segregated from the non-magnetic material. A secondary magnet is fixed near the terminus of the conveying means, and this secondary magnet can also be rotated. A number of chutes extends from the secondary magnet, whereby the material is separated into grades of different contents of magnetic




material. A conveyor having a partition on it for receiving the material and keeping the different grades separate from each other passes through the field of the electromagnets. A pair of shells forms an annular passage around the electromagnets, so that the magnetic material is lifted from the conveyor and carried through the passage by the rotation of the electromagnets. A pair of chutes leads from the passage, and a secondary magnet is arranged near one of the chutes, so that the magnetic material is attracted into the chute and further separated from the non-magnetic material. There are four claims.

END OF VOL. CXVII.

# The Engineer

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VOL. CXVII.—No. 3052] LONDON: FRIDAY EVENING, JUNE 26, 1914. [PRICE SIXPENCE



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Engineering Library


## Assistant Storekeeper Required

for the Gold Coast Government Railway. Two tours of twelve months, with possible extension. Salary £250-£10-£300. Age 25 to 40. Single quarters or an allowance. First-class passages. Liberal leave on full pay. Candidates with a thorough knowledge of book-keeping, locomotive stores, and construction material, should apply at once to the CROWN AGENTS FOR THE COLONIES, Whitehall-gardens, S.W. 1040

## First-class Superintendent

REQUIRED for Public Works Department by Jamaica Government. Permanent appointment after two years' probation. Salary £300-£20-£400 per annum. Free passage. Age 23-35. Other considerations being equal, preference will be given to candidates of Jamaican birth. Corporate Members of the Institute of Civil or Mechanical Engineers preferred. Candidates should have had a good general education, have been trained as a Civil Engineer and explored thereafter on works of construction under an engineer or contractor. Must be competent draughtsmen, levellers and surveyors, with experience of road and street construction and maintenance. Knowledge of building construction and laying-out and construction of sewers and waterworks desirable.

Apply at once to the CROWN AGENTS FOR THE COLONIES, Whitehall-gardens, London. 1030

## The Proprietor of Letters

Patent No. 15,272 of 1910, relating to "BALL BEARINGS,"

DESIRES to DISPOSE of the PATENT or to GRANT LICENCES to interested parties on reasonable terms with a view to the adequate working of the Patent in this country.

Inquiries to be addressed to:

CRUIKSHANK & FAIRWEATHER, LTD., 65-66, Chancery-lane, London, W.C. 1103

## The Proprietors of Letters

Patent No. 14,403 of 1909, relating to "METHOD OF DEODORISING EXHAUST GASES, especially those of Internal Combustion Engines,"

DESIRE to DISPOSE of the PATENT or to GRANT LICENCES to interested parties on reasonable terms with a view to the adequate working of the patent in this country.

Inquiries to be addressed to:—

CRUIKSHANK & FAIRWEATHER, LTD., 65-66, Chancery-lane, London, W.C. 1102

## THE MANCHESTER MUNICIPAL School of Technology

(UNIVERSITY OF MANCHESTER).

Principal: J. C. M. GARNETT, M.A. (late Fellow of Trinity College, Cambridge).

The Session 1914-15 will open on 6th October. Matriculation and Entrance Examinations will be held in July and September.

The Prospectus, forwarded free on application, gives particulars of the Courses leading to the Manchester University Degrees in the Faculty of Technology in the following Departments:—

MECHANICAL ENGINEERING.
ELECTRICAL ENGINEERING.
SANITARY ENGINEERING (including Municipal Engineering).
THE CHEMICAL INDUSTRIES (including General Chemical Technology, Bleaching, Dyeing, Printing, Papermaking, Brewing, and Metallurgy).
THE TEXTILE INDUSTRIES.
PHOTOGRAPHY AND THE PRINTING CRAFTS.
ARCHITECTURE. 945

## University of Sheffield.

DEPARTMENT OF APPLIED SCIENCE.

Dean: Professor W. RIPPER, D. Eng., D.Sc., M. Inst. C.E.

SUMMER COURSE OF ENGINEERING WORKSHOP INSTRUCTION.

The Workshops of the Engineering Department of the University will be open during the month of July for the use of a limited number of students requiring a short course of training in one or other of the following branches:—

1. Fitting and Turning in the Iron Shops.
2. Machine Tool Work.
3. Woodwork and Patternmaking.

Commencing July 1st and ending July 25th (inclusive).

Fee for the four weeks' course, £1 11s. 6d.

Application for admission to the course should be made on an entry form, which may be obtained from

WALTER SWIFT, Secretary.

St. George's-square, Sheffield. 987

## University of Manchester.

FACULTY OF SCIENCE.

DEPARTMENTS OF CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING.

COMPLETE COURSES of STUDY, extending over three years, are arranged for the University Degrees in Civil, Mechanical, and Electrical Engineering.

The Civil and Mechanical Engineering Laboratories have been recently equipped with new plant and apparatus.

The Electrical Engineering Laboratory is housed in a new building which was opened in 1912.

A Prospectus, giving full particulars of the Courses, will be forwarded on application to the REGISTRAR.

The SESSION COMMENCES on the 5th of OCTOBER.

HEADS OF DEPARTMENTS.

Professor J. E. PETAVEL, D.Sc., F.R.S., M.I. Mech. E., A.M. Inst. C.E., A.M. Inst. E.E., Engineering.
Professor R. BEATTIE, D.Sc., M.I.E.E., Electrical Engineering.
Professor HORACE LAMB, Sc.D., LL.D., F.R.S., Mathematics.
Professor H. B. DIXON, M.A., M.Sc., Ph.D., F.R.S., Chemistry.
Professor Sir ERNEST RUTHERFORD, M.A., D.Sc., Ph.D., F.R.S., Physics.
Professor Sir T. H. HOLLAND, K.C.I.E., D.Sc., F.R.S., Geology.
Professor C. A. EDWARDS, D.Sc., Metallurgy.
Associate Professor E. SANDMAN, M. Inst. C.E., directs the studies of students specialising in Water Supply and Irrigation. 667

## County Borough of West Ham.

MUNICIPAL TECHNICAL INSTITUTE, ROMFORD-ROAD, STRATFORD, E.

APPLICATIONS are invited for a JUNIOR ASSISTANT in CIVIL and MECHANICAL ENGINEERING.

Candidates should have a good scientific training and workshop experience.

Salary £120 per annum, with annual increments of £10 to £150.

Forms of application and further particulars can be obtained from the Principal on receipt of a stamped addressed envelope. Applications must be returned on or before Thursday, July 2nd.

H. W. GREAVES, Town Clerk.

9th June, 1914. 897

## Northern Polytechnic Institute, HOLLOWAY, LONDON, N.

The Governors of the above Institute invite APPLICATIONS for the POST of ASSISTANT in the ENGINEERING DEPARTMENT, preferably with workshop, drawing-office, and if possible teaching experience.

Commencing salary £160 per annum.

Appointment to date from the 1st September, 1914.

Applications to be made on special forms to be obtained from the SECRETARY, at the Institute. 983

## County of London.—The London

County Council invites APPLICATIONS for the POSITION of ASSISTANT FOREMAN in METAL WORK.

Salary £100, rising to £175 by yearly increments of £5, subject to the proviso that the salary shall not rise above £155, unless satisfactory reports as to qualifications and experience are submitted.

Applications must be on forms to be obtained, with particulars of the appointment, by sending a stamped addressed foolscap envelope to the Education Officer, London County Council, Education Offices, Victoria Embankment, W.C., to whom they must be returned by 11 a.m. on Tuesday, 7th July, 1914. Every communication must be marked E.2 on the envelope.

Canvassing, either directly or indirectly, will disqualify an applicant.

LAURENCE GOMME, Clerk of the London County Council.

Education Offices, Victoria Embankment, W.C. 1063

## University of Leeds.—Department of ENGINEERING.

APPLICATIONS are invited for the POST of ASSISTANT-LECTURER and DEMONSTRATOR (with special knowledge of Steam Turbines and Internal Combustion Engines).—Particulars may be obtained from the SECRETARY. 999

## Brentford Union.—Hot Water AND HEATING PLANT.

The Guardians of the above-named Union are about to invite TENDERS for RE-ARRANGING the HOT WATER and HEATING INSTALLATION of their separate Infirmary at Isleworth, in accordance with plans and specifications prepared by Mr. W. M. Binny, A.M.I.C.E.

Firms desirous of tendering for this work are invited to send their names, with particulars of recent installations of a similar nature recently carried out by them, to the undersigned not later than the morning of the 1st proximo.

By order, WILLIAM STEVENS, Clerk.

Union Offices, Isleworth, W., 24th June, 1914. 1051

## City of Bradford. — Esholt SEWAGE DISPOSAL WORKS.

CONTRACT No. 21 B.

OUTFALL SEWER IN TUNNEL.

The Corporation invite TENDERS for the COMPLETION of the CONSTRUCTION and MAINTENANCE for twelve Months after completion, of a CIRCULAR OUTFALL SEWER in TUNNEL, from Idlington to Stranford, 10ft. in diameter and 4807 yds. in length, of which 4757 yds. or thereabouts have yet to be constructed, with Observatories, Object Pillars, &c.

Drawings may be seen and copies of specification, conditions of contract, schedule of quantities, and form of Tender may be obtained on and after the 22nd inst. at the offices of either Mr. James Watson, M. Inst. C.E., Waterworks Engineer, Town Hall, Bradford, or Mr. Joseph Garfield, M. Inst. C.E., Sewage Works Engineer, Esholt Hall, near Shipley (Station, Apperley Bridge, Mid. Ry.), on payment of the sum of Five Guineas, which sum will only be returned upon receipt of a bona fide Tender and the return of all the documents.

The contract will be let subject to the Fair Contracts Clauses of the Corporation, which, together with copy of the formal agreement to be executed, may be seen at either of the offices above named, and which the accepted contractor will be required to sign.

Sealed Tenders, endorsed "Outfall Sewer—Contract No. 21 B —Esholt," must be delivered at the office of the undersigned not later than 9 a.m. on Monday, the 20th July, 1914.

The Corporation do not bind themselves to accept the lowest or any Tender.

FREDERICK STEVENS, Town Clerk.

Town Hall, Bradford, 9th June, 1914. 964

## City of Lincoln Waterworks.

TO WATERWORKS ENGINEERS, CONTRACTORS, MACHINERY BROKERS, BUILDERS, &c.

The Waterworks Committee of the Council is open to receive OFFERS for the WHOLE or any part of the MACHINERY, PLANT, PIPES, SAND, &c., as it now stands at the Old Pumping Station at Boultham, London, comprising Worthington and Cornish Engines, Lancashire and Cornish Boilers, Feed Pumps, Travelling Crane, Winches, Chains, Cast Iron Pipes, Valves, Filtering Sand, &c.

Schedules and permission to view may be obtained from Mr. Charles Horobin, Waterworks Engineer, Saltergate.

Offers must be sent in to me, addressed to the Chairman of the Waterworks Committee and endorsed "Offer for Plant," on or before Wednesday, the 15th July next. The highest or any offer will not necessarily be accepted.

WM BAGSHAW, Town Clerk.

Guildhall, Lincoln, 22nd June, 1914. 1053

## County of London.—The London

County Council invites TENDERS for the PROVISION and ERECTION of a new AIR-WASHING SCREEN in connection with the heating and ventilating apparatus ("Plenum" System) at each of the undermentioned Council Schools:—

St. George's-row, Ebury Bridge, S.W.
Christian-street, Whitechapel, E.

The specification, drawings, form of Tender, form of contract, &c., may be obtained from the Chief Engineer of the Council, at the County Hall, Spring-gardens, S.W., after payment to the Cashier of the Council of £1. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender, and shall not have withdrawn the same. The contract documents may be inspected before the payment of the fee.

The person whose Tender is accepted will be bound by the contract to pay wages at rates not less and to observe hours of labour not greater than the rates and hours set out in the Council's list. Particulars of the Council's Standing Orders as to the conditions of Tender and contract are given in every issue of the *London County Council Gazette*. No Tender received after 11 a.m. on 14th day, July, 1914, will be considered. The Council does not bind itself to accept any Tender.

LAURENCE GOMME, Clerk of the London County Council.

County Hall, Spring-gardens, S.W., 24th June, 1914. 1104

## Extension of Date for Receipt of TENDERS FOR LIGHTHOUSE STEAMERS

REQUIRED BY THE COMMONWEALTH OF AUSTRALIA.

It is hereby notified that TENDERS for the above, which were to have been deposited in Melbourne by the 12th August, 1914, can now be received up to the 30th SEPTEMBER, 1914.

Further particulars may be obtained from the OFFICIAL SECRETARY, Commonwealth of Australia, 72, Victoria-street, Westminster, S.W. 1073

## Glamorgan and Carmarthenshire COUNTY COUNCILS.

PROPOSED NEW ROAD BRIDGE AT LOUGHOR.

TO BUILDERS AND OTHERS.

The Joint Committee of the above County Councils invite DESIGNS, SPECIFICATIONS, and TENDERS for the PROVISION, ERECTION, and COMPLETION of a NEW BRIDGE, to carry the 24-inches main road over the River Loughor at Loughor, in substitution for the present bridge.

A copy of the conditions and general particulars, with a plan of the site, will be supplied on application at the office of the County Surveyor, County Hall, Cathays Park, Cardiff, where also the plans of the existing bridge may be inspected.

Designs, specifications, and Tenders are to be delivered, free of cost, at the County Surveyor's office above mentioned not later than 12 noon on Saturday, the 18th day of July, 1914.

The Joint Committee does not bind itself to adopt any design or accept any Tender that may be received.

By direction of the Joint Committee,

T. MANSEL FRANKLEN, Clerk of the Glamorgan County Council.

877

## Goole Urban District Council.

GOOLE DRAINAGE.—CONTRACT No. 4.

The Goole Urban District Council is prepared to receive TENDERS for the MANUFACTURE and ERECTION of a FOUR-TON TRAVELLING CRANE over machinery at their pumping station about a mile from Goole Station on the North-Eastern Railway, in accordance with a plan and specification prepared by Messrs. John Taylor and Sons, Civil Engineers, of Caxton House, Westminster.

Contractors desirous of tendering may obtain copies of the specification, with form of Tender, at the offices of the Clerk to the Goole Urban District Council, upon payment of £2 (cheque only), which will be returned upon receipt of a bona fide Tender. The drawing may be inspected either at the office of the Clerk to the Council, at Goole, or at the Engineer's Office, Caxton House, Westminster.

Tenders, endorsed "Goole Drainage," must be delivered in a sealed package, addressed to the undersigned, at the Council Offices, Goole, before 12 noon on Monday, the 6th day of July, 1914.

The Council do not bind themselves to accept the lowest or any Tender.

By order, ROBERT TYSON, Clerk to the Council.

1045

## Metropolitan Water Board.—

TENDERS FOR STEEL ROOFS, &c., BATTERSEA.

The Metropolitan Water Board invite TENDERS for the SUPPLY and ERECTION of the following steel and iron work, &c., at the Battersea Works of the Board:—

BOILER HOUSE ROOF,
COAL BUNKER and ROOF,
METER SHOP ROOF, and
FITTING SHOP ROOF.

Forms of Tender, specifications and drawings may be obtained at the office of the Engineer, Savoy-court, Strand, London, W.C., on and after Friday, 26th June, 1914, on the production of an official receipt for the sum of £2 2s. (Two Guineas), which sum must be deposited with the Board's Accountant at Savoy-court, Strand, W.C., and will be returned upon receipt of a bona fide Tender.

Tenders, enclosed in sealed envelopes, addressed to the "Clerk of the Board, Metropolitan Water Board, Savoy-court, Strand, W.C.," and endorsed "Tender for Steel Roofs, &c., Batteries," must be delivered at the offices of the Board not later than 10 a.m. on Thursday, the 16th July, 1914.

The Board do not bind themselves to accept the lowest or any Tender.

A. B. PILLING, Clerk of the Board.

Savoy-court, Strand, W.C., 24th June, 1914. 1115

## Port of London Authority.

TO BUILDERS AND CONTRACTORS.

PRINCE REGENT'S LANE ESTATE—HOUSING SCHEME.

The Port of London Authority invite TENDERS for the CONSTRUCTION of DWELLING HOUSES, ROADS, SEWERS, EARTHWORK, and Contingent Works to be carried out in connection with the Housing Scheme, Prince Regent's Lane Estate, West Ham.

The drawings can be inspected between the hours of 10.0 a.m. and 4.0 p.m. on ordinary week-days and between the hours of 10.0 a.m. and 12 noon on Saturdays, and copies of the contract, general conditions, specification, bills of quantities, instructions to persons tendering, and form of Tender can be obtained from the Chief Engineer of the Port Authority, Mr. C. R. S. Kirkpatrick, on and after Saturday, 4th July, 1914, on application at 109, Leadenhall-street, E.C., upon payment of a deposit of £5 5s.

The amount of the deposit will be returned only after the receipt of a bona fide Tender (not subsequently withdrawn), delivered in accordance with the instructions to persons tendering, accompanied by the documents supplied for the purpose of making up the Tender.

Tenders are to be delivered not later than 10 a.m. on Thursday, 23rd July, 1914. In the event of the existing building dispute not being settled on or before 13th July, 1914, the date for the receipt of Tenders will be postponed to such later date as may be fixed.

F. AYLIFFE, Secretary.

109, Leadenhall-street, E.C. 26th June, 1914. 1120

## The Bengal and North-Western RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY and DELIVERY of:—

(a) RED and WHITE LEAD.
(b) METALS (COPPER, TIN and ZINC),

as per specification to be seen at the Company's offices.

Tenders, addressed to the undersigned, and marked "Tender for Red and White Lead," or as the case may be, are to be lodged not later than noon on Tuesday, the 7th day of July, 1914.

For each specification a fee of 10s. will be charged, which cannot, under any circumstances, be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board, ALEXANDER IZAT, Managing Director.

237, Gresham House, Old Broad-street, London, E.C., 24th June, 1914. 1106

RIBBLE NAVIGATION.

## The Corporation of Preston

invite TENDERS for the CONSTRUCTION of TWO SUCTION HOPPER DREDGERS, each of 1500 tons capacity.

Specifications may be obtained from the undersigned on payment of £2 2s., which will be returned on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Suction Dredgers," must be delivered to the Engineer at his office by 9 a.m. on 18th July, 1914

JAMES BARRON, M. Inst. C.E., Engineer and General Superintendent.

Dock Offices, Preston. 1039

## The Great Indian Peninsula RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely:—

Helical and Volute Springs. | Carriage Fittings.
India-rubber Sheets, &c. | Hemp, Ropes, &c.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Helical and Volute Springs," or as the case may be, not later than 11 o'clock a.m. on Thursday, the 2nd July, 1914.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALFOLE, Secretary.

Company's Offices, 48, Copthall-avenue, E.C., London, 24th June, 1914. 1118

TO ENGINEERS AND OTHERS.

## The Metropolitan Asylums

BOARD invite TENDERS for the INSTALLATION of NEW STEAM BOILERS and INCIDENTAL WORK at Tooting Bec Asylum, Tooting, S.W., in accordance with drawings and specifications, prepared by Mr. W. T. Hatch, M. Inst. C.E., M.I. Mech. E., Engineer-in-Chief.

The drawings, conditions of contract, specification, and form of Tender may be inspected at the Office of the Board, Embankment, E.C., on and after 10 a.m. on Thursday, June 25th, 1914, and can then be obtained upon payment of a deposit of £5. The amount of the deposit will be returned only after the receipt of a bona fide Tender sent in accordance with the instructions on the form of Tender, and after the specification and drawings have been returned.

Tenders, addressed as noted on the form, must be delivered at the Office of the Board not later than 10 a.m. on Monday, 20th July, 1914.

(By order) T. DUNCOMBE MANN, Clerk to the Board.

June 22nd 1914. 1062

## The Electricity Committee of

the Ashton-under-Lyne Corporation invite TENDERS for the PURCHASE of a DEEP WELL PUMP, 5000 gals. per hour. Further particulars and form of Tender may be obtained from the Borough Electrical Engineer, Wellington-road, Ashton-under-Lyne. Sealed Tenders, addressed to the undersigned, must be received not later than noon, Wednesday, 1st July, 1914. By order, JOHN NEAL, Borough Comptroller, Town Hall, Ashton-under-Lyne. June 17th, 1914 993

## The South Indian Railway

COMPANY, Limited, are prepared to receive TENDERS for the SUPPLY of:—

No. 1. BRIDGE WORK—7 spans of 20ft. square (deck) } About
15 spans of 40ft. square (deck) } 155 tons.

No. 2. SCREW SPIKES—No. 465,460, for 35 lb. Rails, about 202 tons.

No. 3. STEEL BEARING PLATES—No. 33,000, for 35 lb. Rails, about 51 tons.

No. 4. FISH-BOLTS, NUTS, and WASHERS—about 15 tons.

Specifications and forms of Tender may be obtained at the Company's Offices.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Bridge Work," or as the case may be, must be left with the undersigned not later than One o'clock on Wednesday, the 8th July, 1914.

The Company are not bound to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 20s. each for Specifications Nos. 1 and 2 and 10s. each for Specifications Nos. 3 and 4.

Copies of the drawings may be obtained on payment at the offices of Robert White, Esq., M. Inst. C.E., Consulting Engineer to the Company, 3, Victoria-street, Westminster, S.W.

By order, V. E. DE BROË, M. Inst. C.E., for Managing Director.

Company's Offices, 91, York-street, Westminster, S.W., 23rd June, 1914. 1084

## Bicester Urban District Council.

WATER FITTER, capable of Working a Pumping Plant, driven by Crossley's gas engines, WANTED at once.

The duties will include pumping the water, laying services, and repairs to same, and any other work required by the Council or their Surveyor.

Applications, endorsed "Water Fitter," stating age, experience, wages required, and when disengaged, with copies of two recent testimonials, to be sent to me not later than Monday, the 6th July next.

E. F. TANNER, Clerk to the Council.

Bicester, Oxon. 1025

## Notice.—It Has Come to the

knowledge of the British Oxygen Co., Ltd., that plants for the production of Oxygen by the liquefaction of air have recently been offered for sale in this country.

NOTICE IS HEREBY GIVEN that the BRITISH OXYGEN CO., Ltd., are SOLE OWNERS of the LINDE BRITISH PATENTS for the Separation of Oxygen and Nitrogen from Liquid Air by means based on rectification. Their rights have been unanimously allowed by the final Court of Appeal after exhaustive litigation, the decision giving, in effect, to the Company very wide protection in the commercial production of oxygen and nitrogen from liquid air 2001

## Wanted, an Experienced Bridge

ERECTOR to go to Uruguay. State age, previous experience, and salary expected.—Apply, in the first instance, to the HORSEHAY CO., Ltd., Horsehay, Shropshire. 1035 A

## Wanted, Engineer-Draughtsman,

experienced in Winch Building and Pipe Arrangements. Age, wage, and references required.—Apply to J. S. DOIG (Grimsby), Ltd., Fish Docks, Grimsby. 1044 A

## Wanted for Portuguese West

Africa, Loanda, a PRACTICAL MAN, experienced in the Manufacture of Soap and Extraction of Oils. Knowledge of the chemistry required for this industry essential.—State age, experience, and salary required to H. 678, Lee and Nightingale, Liverpool. P775 A

## Wanted for Small Repetition

Work on Milling and Boring Machines, an EXPERT MAN to Set Tools and Supervise the Work. State age, experience, and wages required.—Address, 1057, Engineer Office, 33, Norfolk-street, Strand, W.C. 1057 A

## Wanted Immediately, a Capable

MAN to Design Paraffin Engines for Launches and Lighting Plants to Admiralty requirements. Only those who thoroughly understand the work and have held similar positions need apply.—Address, 1047, Engineer Office, 33, Norfolk-street, Strand, W.C. 1047 A

## Wanted, in London, Assistants

with good general Engineering Training, and practical experience in drawing-office; able to take out quantities, make estimates, draw up specifications, &c., for plant and machinery required for large works—Write, giving full particulars of experience, age, and salary expected to Box N., care of Burtons, General-buildings, Aldwych, London. 1079 A

## Wanted, Works Manager for

small country Engineering Works. Applicant must thoroughly understand the control of men in the erecting, turning, fitting, foundry, and carpenter's shops; be a capable mechanical engineer and draughtsman and about 30 to 35 years of age.—state age, qualifications, references, previous experience, and wages required, to BARROWS and CO., Ltd., Agricultural and General Engineers, Banbury, Oxfordshire. 1058 A

## Assistant Manager Required in

Milling Department of Tool Works; must have a thorough knowledge of the business and competent to take charge of the turning, milling, and grinding departments.—Address, with full particulars of experience, age, &c., to 1105, Engineer Office, 33, Norfolk-street, Strand, W.C. 1105 A

## Capable Man (Young) Required

for Estimating and Correspondence at Engineering Works in Midlands; knowledge of drawings essential; permanent post for suitable man.—Address, stating age, experience, salary, to 950, Engineer Office 33, Norfolk-street, Strand W.C. 950 A

## Elevating and Conveying

MACHINERY.—Old-established firm wish to develop this branch of their business and REQUIRE the SERVICES of an ENGINEER with an established connection and reliable experience to secure orders and generally assist in this department.—Address, P768, Engineer Office, 33, Norfolk-street, Strand, W.C. P768 B

## SMALL ADVERTISEMENTS, SITUATIONS, FOR SALE, &c.

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Numerical Index to Advertisements, PAGE LXXIII.

Subject-Matter Index to Advertisements PAGE LXXV.

**Engineer-Draughtsman Required** by Sawmill Engineers to Control Tool Dept., Repairs, Mechanical Staff, Correspondence, &c. Experience with woodworking machines desirable. Methodical, energetic, and reliable man only.—State experience, age, salary required, &c., to 1046, Engineer Office, 33, Norfolk-street, Strand, W.C. 1046 A

**Engineer Wanted with Commercial** training and Eastern trading experience to Represent British Company in French Indo-China on salary and commission. Only first-class applicants considered. Give full information as to experience, age, and salary required. Testimonials essential.—Address, 1071, Engineer Office, 33, Norfolk-street, Strand, W.C. 1071 A

TECHNICAL CORRESPONDENCE.

**Young Mechanical Engineers,** with good general and professional education, entirely familiar with German, are WANTED for the Sales Depart. of a Berlin firm of international reputation, to take care of the extensive English-German technical correspondence. Preferred are those who have had experience in water, gas, and steam fixtures. Position is permanent, with chances for good advancement.—Applications in German, giving details of education, experience, reference, and desired salary, under J. F. 8035, care of Rudolf Mosse Advertising Agency, Berlin, S.W. 1045 A

**Wanted, a Competent Locomotive** DRAUGHTSMAN, thoroughly acquainted with modern Main Line Practice. State age, wage, and qualifications.—Address, 1036, Engineer Office, 33, Norfolk-street, Strand, W.C. 1036 A

**Wanted by Motor Car Works** near London, a first-class DRAUGHTSMAN with experience in high-class design.—Write, giving full particulars of age, experience, and salary required, to 1033, Engineer Office, 33, Norfolk-street, Strand, W.C. 1033 A

**Wanted, Draughtsmen, Accustomed** to Structural Work and Elevating and Conveying Machinery.—Apply, stating age, experience, salary expected, and enclosing copies of testimonials to SPENCER and CO., Limited, Engineers, Melksham. 1067 A

**Wanted, Draughtsman,** for Civil Engineer's office (London). Age about 26. Able to use theodolite and level; knowledge of hydraulics, sewerage, and building construction. Permanency.—Address, 1796, Engineer Office, 33, Norfolk-street, Strand, W.C. 1796 A

**Wanted, Draughtsman, Well** up in all the branches of Motor Vehicle Construction. —Write, giving full particulars, to 1788, Engineer Office, 33, Norfolk-street, Strand W.C. 1788 A

**Wanted, First-class Motor Car** DRAUGHTSMAN at a salary of about £3 per week for large firm near London.—Write, stating age and experience, to Box 1725, Willing's, 125, Strand, W.C. 833 A

**Wanted, Head Draughtsman** for Railway Carriage and Wagon Rolling Stock. Must have had works training and experience in drawing-office organisation.—Address, 1031, Engineer Office, 33, Norfolk-street, Strand, W.C. 1031 A

**Wanted, Junior Draughtsman,** must be an accurate tracer.—Address, 1799, Engineer Office, 33, Norfolk-street, Strand, W.C. 1799 A

**Wanted, Junior Mechanical** DRAUGHTSMAN, quick, accurate, and adaptable to needs of employer.—Address, stating age, experience, and salary required, to 966, Engineer Office, 33, Norfolk-street, Strand, W.C. 96 A

**Wanted, Smart Young Draughtsman,** experienced in Bridge, Roof, and Structural Steelwork.—state age, experience, and salary required, to JOSEPH WESTWOOD and CO., Ltd., Napier Yard, Millwall, E. 1101 A

**Bridge and Structural Draughtsmen** REQUIRED. Must be first-class men, well up in Railway Bridge Design. Applications will be considered only from men with several years' practical and theoretical experience.—The CLEVELAND BRIDGE CO., Ltd., Darlington. 903 A

**Commercial Vehicle Draughtsman** WANTED, with experience of up-to-date Commercial Vehicle Design.—Address, 1059, Engineer Office, 33, Norfolk-street, Strand, W.C. 1059 A

**Draughtsman Required with** experience in Wagons, Carriages, and Tramway Cars for Estimating Department of large firm of rolling stock builders to check and be responsible for quantities.—Address, stating age, experience, and wages required to 1779, Engineer Office, 33, Norfolk-street, Strand, W.C. 1779 A

**Draughtsman Wanted at Once,** well up in Marine Oil Engine Work, a capable, accurate, and quick man. State ages, experience, and salary required.—Address, 1064, Engineer Office, 33, Norfolk-street, Strand, W.C. 1064 A

**Draughtsman Wanted.—Only** experienced men need apply.—State age, salary, and experience, to HEAD DRAUGHTSMAN, A. Ransome and Co., Ltd., Newark-on-Trent. 1075 A

**Good Draughtsman Required,** used to High-class Automobile Work.—Apply, stating age, experience, and salary required, to D. NAPIER and SON, Limited, Acton Vale, London, W. 1034 A

**Leading Draughtsman Wanted** by small firm making Iron and Wood Buildings, Roofing, and the like. Full knowledge of strains and stresses required. —Apply by letter, stating age and salary required, giving full particulars, and earliest date at liberty (which will be treated as confidential), to the MANAGER, Darlington Construction Co., Ltd., Bank Top, Darlington. 1069 A

**Mechanical Draughtsman** WANTED for General Engineering Works.—Address, stating qualifications and wages required, 1048, Engineer Office, 33, Norfolk-street, Strand, W.C. 1048 A

**Required, Junior Draughtsman,** used to Engineering Work, with good mathematical knowledge, capable of calculating strains. Near London.—Address, 1070, Engineer Office, 33, Norfolk-street, Strand, W.C. 1070 A

**Wanted, by a Large Firm of** Casement Manufacturers, a Capable FOREMAN, who has had experience in the most up-to-date methods of making casements. Must be a good organiser, and capable of controlling a large body of men.—Address, stating age, salary required, and giving full particulars of experience, to 959, Engineer Office, 33, Norfolk-street, Strand, W.C. 959 A

**Wanted, First-class Foreman** for Automatics, Turrets, and Centre-lathes for large repetition works near London.—Address, giving particulars of age, experience, references, and wages expected, to 1783, Engineer Office, 33, Norfolk-street, Strand, W.C. 1783 A

**A Capable Energetic Foreman** (MOULDER) to Take Charge of old-established Brass Foundry (London). Good wages to competent man.—Apply by letter, stating previous experience, to 1780, Engineer Office, 33, Norfolk-street, Strand, W.C. 1780 A

**Assistant Locomotive Foreman.** REQUIRED, YOUNG LOCO. ENGINEER for Tropical Africa, with shop and running shed experience; abstainer preferred.—Apply by letter to A. B. C., Box 250, Coops, 5, Copthall-court, London, E.C. 1111 A

**Foreman Fitter Wanted, Having** experience in Producing Steam Engine Parts. Must have held similar position.—State experience, age, and salary required, R. GARRETT and SONS, Ltd., Leiston. 1068 A

**Foreman Over Brass Finishing** Dept., Manchester Works; must be smart man, with up-to-date experience in manufacturing Cocks, Valves, Lubricators, &c., on repetition lines; non-union. State age, salary, and experience, and say when at liberty.—Address, 1100, Engineer Office, 33, Norfolk-street, Strand, W.C. 1100 A

**Foundry Foreman Wanted for** small foundry (100 hands); must have first-class experience, able to recognise and introduce modern methods. State age, experience, when free, and give references.—Replies, in confidence to 1065, Engineer Office, 33, Norfolk-street, Strand, W.C. 1065 A

**Machine Shop Foreman Required,** used to Repetition work, able to produce tools and simple jigs. Good organiser and disciplinarian.—Address, stating age, wage, and experience, 1066, Engineer Office, 33, Norfolk-street, Strand, W.C. 1066 A

**Wanted, Representative for** London for Heating and Ventilating and Dust Exhausting Plants.—Apply, STANDARD ENGINEERING CO., Ltd., Leicester. 839 A

**A Large Firm of Gas Engineers** have a VACANCY for a smart and well-educated Young GENTLEMAN, to act as Assistant Representative. State age. —Address, 1068, Engineer Office, 33 Norfolk-street, Strand, W.C. 1068 A

**Engineering Trade Representatives.**—A London firm, with several important specialities for all classes of Engineers, WANTS an Exclusive Energetic SALESMAN for defined area.—State (in confidence), age, experience, references, area travelled, &c., to VISHADDUR, Haddon's Advertising Offices, Salisbury-square, London, E.C. 9072 A

**Travellers in Engineering** SPECIALITIES WANTED to take an additional representation on commission for an article having special interest to firms manufacturing or selling internal combustion engines of all types for automobile, stationary and marine work. Only those with practical knowledge need apply.—Address, 1075, Engineer Office, 33, Norfolk-street, Strand, W.C. 1075 A

**Wanted, a Drawing-office Clerk** accustomed to Automobile Specification and drawing-office routine work for motor car works near London.—Write, giving full particulars of age, experience, and salary expected, to 1032, Engineer Office, 33, Norfolk-street, Strand, W.C. 1032 A

**Wanted by Shipbuilders and** Dock Owners at Shanghai an ESTIMATING CLERK, not over 30, for new and repair work. Must have had drawing-office experience and filled similar position before. Three years' engagement at £25 per month; passage paid out and home.—Reply, stating experience, with testimonials, to STOCKTON and CO., 16, Philpot-lane, London, E.C. 1789 A

**Wanted, Competent Works** CLERK for large quarries; able to supervise wages, stores, &c. Permanent position for suitable man.—Address, stating salary required, age, and full particulars of past experience, to 1029, Engineer Office, 33, Norfolk-street, Strand, W.C. 1029 A

**Quotation Clerk, Young, Energetic** industrious, preferably with shops, drawing-office, and heating engineering experience, REQUIRED by large Firm trading in Iron and Steel, Central Heating Boilers, &c. &c. Progressive position for good man.—Address, 1792, Engineer Office, 33, Norfolk-street, Strand, W.C. 1792 A

**A Buyer of Great Experience** and initiative is DESIRING a CHANGE. Many years with LARGEST ENGINEERING COMPANY; used to all raw and finished supplies; unique knowledge of markets.—Address, 1787, Engineer Office, 33, Norfolk-street, Strand, W.C. 1787 B

**A Successful American Blast-Furnace** MANAGER is OPEN to ENGAGEMENT. Technical education, over 30 years' experience in design, construction and practical management. Spiegel, low phosphorus, basic and acid Bessemer and special foundry irons. Large experience in remodelling and improving furnace plants. Highest references.—Address, 965, Engineer Office, 33, Norfolk-street, Strand, W.C. 965 B

**Austrian Gentleman, Age 22,** having already spent one year in similar factory at Chemnitz, DESIRES to ENTER OFFICE of English firm making machines for textile manufacturing, as volunteer without salary.—Address, 1097, Engineer Office, 33, Norfolk-street, Strand, W.C. 1097 B

**Automobile Engineer, Sound** practical and technical training, with several years' experience in executive positions with some of the best American auto. firms and an expert in rapid and accurate production,

SEEKS BERTH as
WORKS or ASST. WORKS MANAGER
with a progressive motor concern.
Address, 1791, Engineer Office, 33, Norfolk-street, Strand, W.C. 1791 B

**Commercial Designer and** DRAUGHTSMAN, varied experience, WISHES to TAKE UP COMMERCIAL SIDE; salary not first consideration.—Address 1765, Engineer Office, 33, Norfolk-street, Strand, W.C. 1765 B

**Continental Inspections of All** kinds UNDERTAKEN by ENGLISH ENGINEER. Many years' experience in France, Germany, and Belgium.—JONES, 2, rue de la Grosse Tour, Brussels. 1119 B

**Diesel Engineer and Designer,** age 29, having 10 years' first-class experience in the Designing and Testing of Diesels, is OPEN to ACCEPT a POSITION of RESPONSIBILITY.—Address, 1764, Engineer Office, 33, Norfolk-street, Strand, W.C. 1764 B

**Engineer and Millwright (Age** 32) REQUIRES POST, extensive experience in mechanical and electrical and constructional work, pumping plants, &c.; technical training, draughtsman; home or abroad.—Address, 1795, Engineer Office, 33, Norfolk-street, Strand, W.C. 1795 B

**Engineer (24), Mechanical and** Electrical, Crewe loco., Newcastle-on-Tyne elec. supply, Stud. I.C.E., and passed A.M.I.C.E. exam., several certificates, full technical knowledge, SEEKS BERTH.—Address, 1750, Engineer Office, 33, Norfolk-street Strand, W.C. 1750 B

**Engineer (28), A.M.I.A.E.,** Mechanical and Automobile, sound works and designing experience, overhaul and prep.-in, used to control of large staffs, manager of well-known firm of light car manufacturers, DESIRES RESPONSIBLE POSITION, Sales or Works, or as Manager of good Garage with room for development; keen worker; highest references; London or provinces.—Address, 1801, Engineer Office, 33, Norfolk-street, Strand, W.C. 1801 B

**Engineering Student, Had 4** years in shops of large printing engineering firm, WANTS SITUATION during college vacation, preferably drawing office.—Address, 1774, Engineer Office, 33, Norfolk-street, Strand, W.C. 1774 B

**Gentleman of Good Family,** who speaks French fluently, with ten years' experience in gas and motor engines, thoroughly able to manage a firm and control workmen, SEEKS SITUATION; would work three months without salary to prove capability, if prospect of good salary.—Address, 1762, Engineer Office, 33, Norfolk-street, Strand, W.C. 1762 B

**Managing Director, Shortly** resigning his present position, DESIRES similar APPOINTMENT or PARTNERSHIP with Consulting Engineer; 25 years' constant experience in all branches of engineering, commercial and practical. Specialist in condensing, including evaporative and ejector condensers.—Address, 1771, Engineer Office, 33, Norfolk-street, Strand, W.C. 1771 B

**Manufacturers of Motor Vehicles** REQUIRING the SERVICES of an ENGINEER are invited to COMMUNICATE with the advertiser. The latter is an engineer of 15 years' standing, having for twelve years held responsible positions in the motor car industry. Being still actively engaged therein, and having some time at his disposal, he is prepared to offer his services in a consultative capacity to a firm of standing who require the services of an engineer. He is fully qualified to originate first-class designs on a commercial basis and possesses also a thorough knowledge of modern shop practice and organisation. Competent to advise on all matters relating to design, production, and shop management.—Address, 1768, Engineer Office, 33, Norfolk-street, Strand, W.C. 1768 B

**Mech. Engineer (German, 29),** graduate of Technische Hochschule, München, theoretically and practically thoroughly trained, familiar with all hydraulic calculations, specially experienced in water turbines, governors for same, and steam turbines, SEEKS POSITION.—Letters to BELOW, 2, Lützowstr., Naumburg a. S., Germany. 1725 B

**Mechanical Engineer, Technical** training, 15 years' varied experience in responsible positions, REQUIRES POST as MANAGER in Engineering or Manufacturing Business, or would join as a Junior Partner investing £1000.—Address, 1777, Engineer Office, 33, Norfolk-street, Strand, W.C. 1777 B

**Mechanical Engineer (27),** single, just returned from abroad, DESIRES RE-APPOINTMENT. Thorough practical and theoretical knowledge; used to control of men. Excellent testimonials. Prefer contractor's work abroad.—Address, 1770, Engineer Office, 33, Norfolk-street, Strand, W.C. 1770 B

**Modern Foundry Manager,** employed as General Foreman with large Corporation in United States, DESIRES PROGRESSIVE POSITION in EUROPE. Trained metallurgist and educated foundryman of proven ability executive and organiser. Fourteen yrs. practical experience in Gt. Britain, seven in United States. Building, remodelling, and equipping plants for rapid and economical production of high-grade castings, for pumps, air compressors, machine tools, locomotives, steel-mill equipment, marine engines, gas producers, steam, kerosene, and gas tractors, agricultural implements, light hardware. Thorough company man; married; strictly temperate; age 36 yrs.; unquestionable character; highest references.—Address, 1014, Engineer Office, 33, Norfolk-street, Strand, W.C. 1014 B

**Position of Trust, Under Works** Manager, DESIRED by Young Mech. Engineer; 12 years shops and D.O.; tech. training; salary no object. Address, 1790, Engineer Office, 33, Norfolk-street, Strand, W.C. 1790 B

**The Late Managing Director** of a large firm of internal combustion engine manufacturers is OPEN to an ENGAGEMENT in a position of trust. Good organiser, energetic; highest possible references. Address, 1776, Engineer Office, 33, Norfolk-street, Strand, W.C. 1776 B

**Works Manager (34), M.I.** Mech. E., will shortly be DISENGAGED; civil, structural, mechanical, and bridge building engineer, with first-class experience at home and abroad; knowledge of Spanish.—Address, 1640, Engineer Office, 33, Norfolk-street, Strand, W.C. 1640 B

**Young Engineer, Just Resigned** from P.O. Engng. Dept., anxious for APPOINTMENT. Automobile and electrical experience in wks and D.O.; certificates.—MANN, 3, Abbotsford-avenue, South Tottenham. 1769 B

**Junior Draughtsman (General** Engineering) REQUIRES CHANGE, with a prospect of advancement. Shop experience. Good reference. Not afraid of work.—SUTTON, c/o Fisher and Sons, Consulting Engineers, Pontypool, Mon. 1689 B

**Mechanical Draughtsman (26),** with works experience, DESIRES APPOINTMENT; accustomed to good general engineering, also haulage and winding gear, &c. Best testimonials.—Address, 1785, Engineer Office, 33, Norfolk-street, Strand, W.C. 1785 B

**Engineer, General Foreman,** 25 years' experience general engineering, gas, oil engines, semi-Diesel; smart, energetic, resourceful.—Address, 1786, Engineer Office, 33, Norfolk-street, Strand, W.C. 1786 B

**Foreman Erector Desires En-** GAGEMENT abroad. Capable of taking sole charge, books, level and foundations; just finished ropeway in W. Africa (3½ years). Varied experience, construction, bridges, headgears, engine roofs, stacks, &c.; several countries, mostly Government work.—Address, 1660, Engineer Office, 33, Norfolk-street, Strand, W.C. 1660 B

**Foundry Foreman (Modern), at** present managing the iron and brass foundries, also pattern shops, of well-known firm, would be pleased to hear from the heads of firms who have a PROGRESSIVE POSITION to offer advertiser. Age 38. Foundry engineering abilities. Successful organiser; tactful and capable handler of men. Experienced in loam, and green sand moulding. Expert with Tabor, Mumford's, &c., moulding machines, cupolas, &c. Company's man. Married. Commercial, piecework, bonus, and card system experience.
Address, 1762, Engineer Office, 33, Norfolk-street, Strand, W.C. 1762 B

**Position as General Foreman by** a thorough practical and up-to-date man, age 43, with large and varied experience as foreman fitter and erector, also machine shop foreman in large motor works. Machine tools, general engineering, and millwrighting a speciality.—Address, 1776, Engineer Office, 33, Norfolk-street, Strand, W.C. 1776 B

**Secretary and Commercial** MANAGER (35), F.C.I.S., REQUIRES APPOINTMENT. First-class credentials and experience, accounting, costing, organising, and administrative.—Address, 1781, Engineer Office, 33, Norfolk-street, Strand, W.C. 1781 B

**A Large Firm of Engineers in** the Midlands have an opening for a youth of good education as PREMIUM PUPIL, the course to include both Works and Drawing-office.—Address, 2007, Engineer Office, 33, Norfolk-street, Strand, W.C. 2007 B

**Boy, Leaving School, is Desirous** of LEARNING MECHANICAL ENGINEERING. Willing to pay small premium. Wages required. Address, ENGINEER, 23, West Avenue-road, Walthamstow. 1784 B

**Engineering Pupil.—Firm** (Government Contractors), employing 600 hands, have VACANCY; varied classes of work done, affording excellent opportunities; premium moderate.—Address, 2000, Engineer Office, 33, Norfolk-street, Strand, W.C. 2000 B

**Pupil.—Firm, Marine Surveyors,** Consulting Engineers, have VACANCY. Premium £250. Repaid in salary. State fullest particulars, experience, education.—Box 1946, Willing's, 125, Strand, W.C. 1112 B

**Pupil.—The Boroughand Water-** WORKS Engineer (A.M.I.C.E.) of Leamington has a VACANCY in his Office for a PUPIL.—Address, TOWN HALL. 2013 B

**A. M.I.C.E. and Stud. Inst. C.E.** EXAMS.—A practical ENGINEER, A.M.I.C.E., A.C.G.I., COACHES for the above by CORRESPONDENCE with the greatest success; only one non-success in the last 12 exams; excellent testimonials; terms moderate; send for booklet.—Address, 2022, Engineer Office, 33, Norfolk-st., Strand, W.C. 2022 B

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| 3 | " | 6 | " | × 5 | " | " " |
| 3½ | " | 7½ | " | × 6 | " | " " |
| 4½ | " | 9 | " | × 5 | " | " " |
| 5 | " | 10 | " | × 6 | " | " " |
| 6 | " | 12 | " | × 7 | " | " " |
| 7 | " | 14 | " | × 8 | " | |
| 8 | " | 16 | " | × 10 | " | |
| 9 | " | 18 | " | × 12 | " | |
| 10 | " | 20 | " | × 14 | " | |
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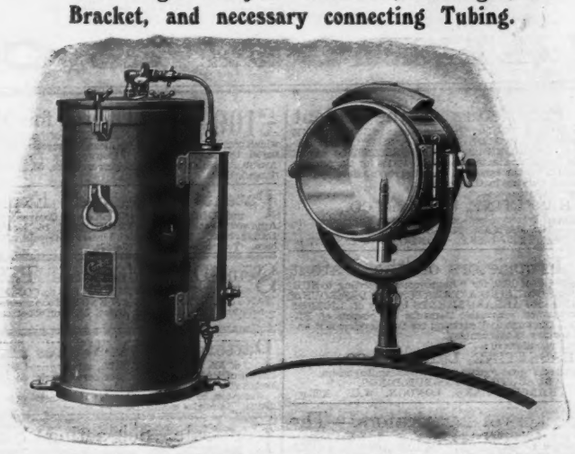

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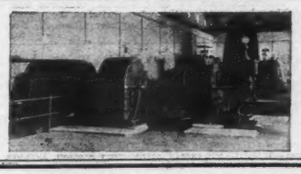

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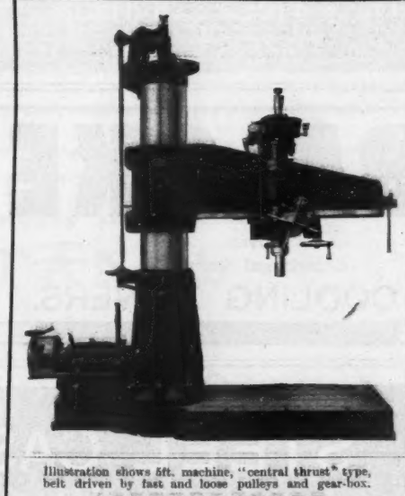

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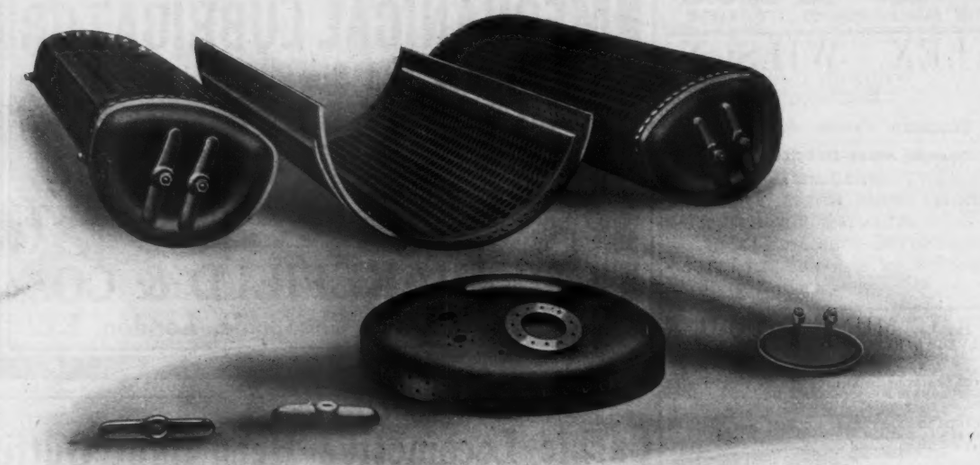

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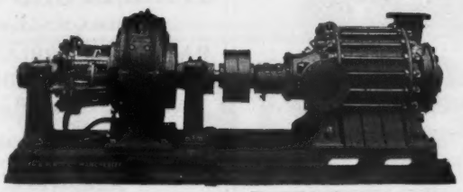

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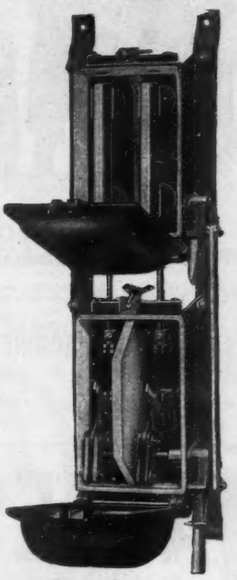

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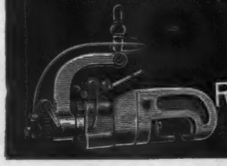

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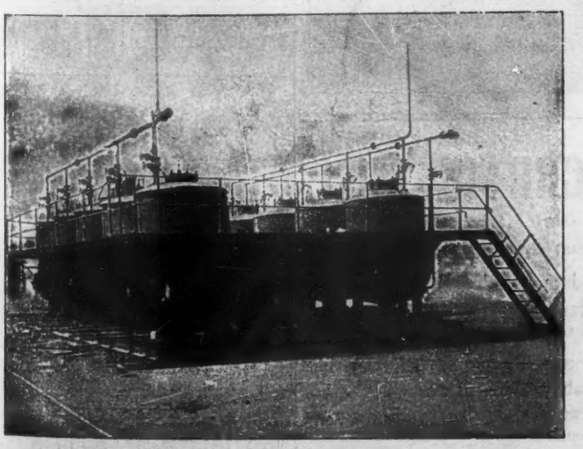

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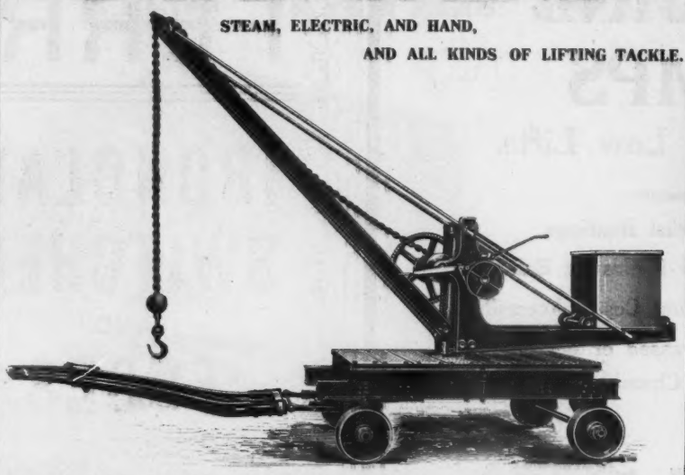

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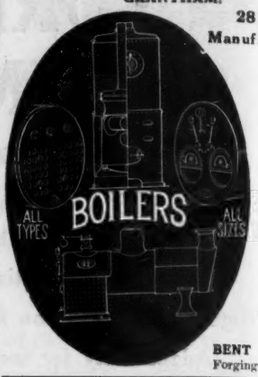


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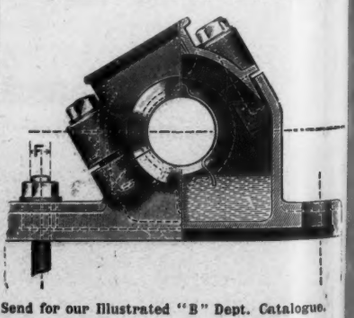

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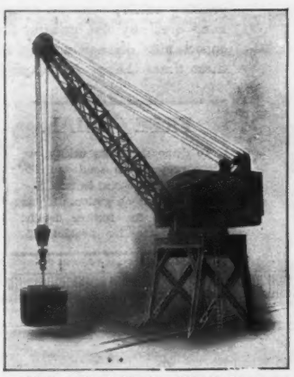

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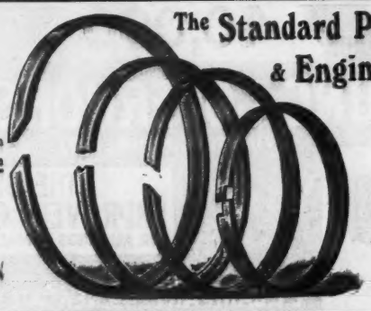

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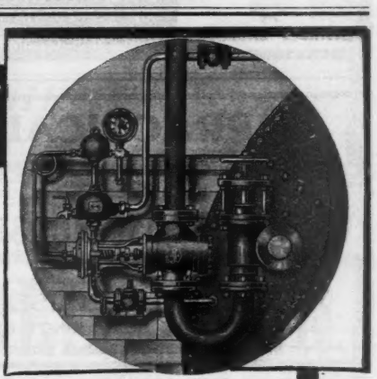

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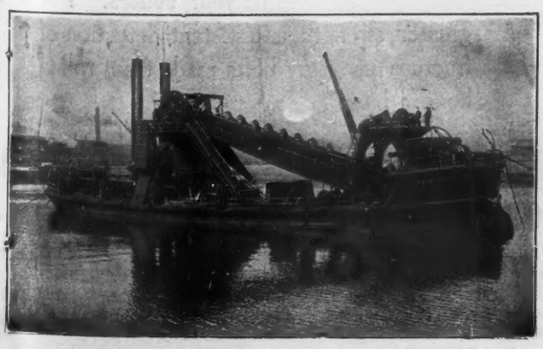

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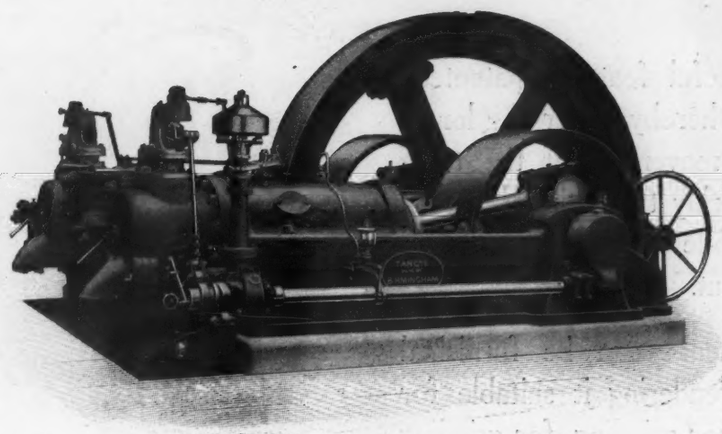

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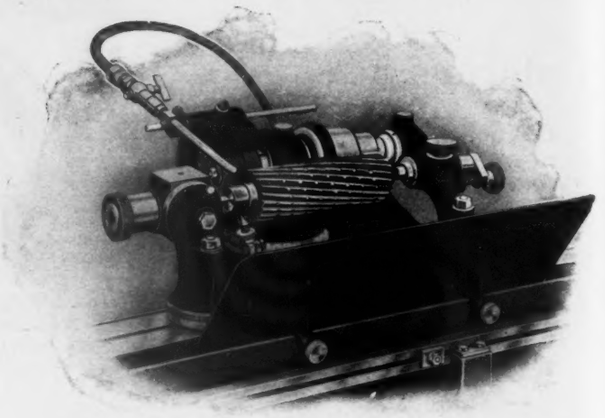

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| Swing with raised centres ... ... | 15in. |
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# High-speed Engines

FOR

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***Patented Improvements giving Highest Efficiency.***

**STANDARD SIZES IN STOCK FOR EARLY DELIVERY.**

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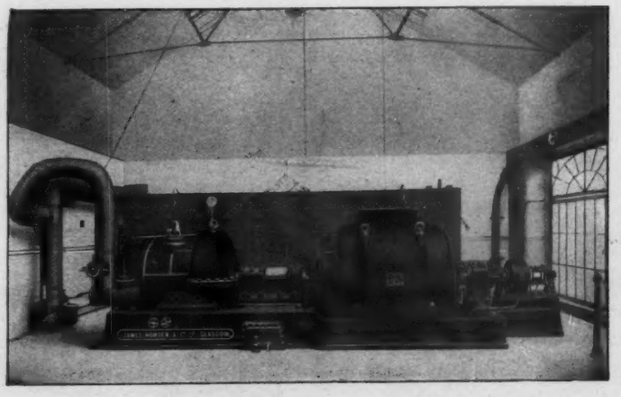

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Installed at Messrs. James Scott, Sons, Ltd., Dundee.

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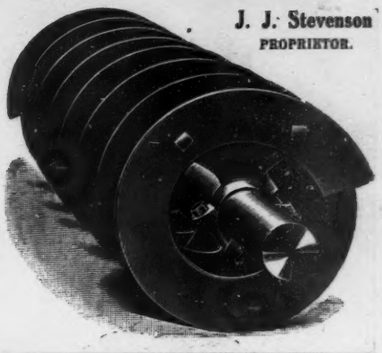

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SIGNALLING APPARATUS IN ENGINE CAB.

Cabins.
Level Crossing Gates.
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Harbour Signals.
Long-burning Lamps.
New "Over-Rail" Lock-Bar.
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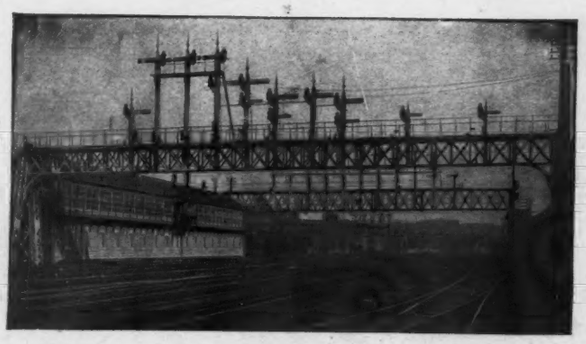
AUTOMATIC TRAIN STOP & Audible Locomotive Cab Signal

SIGNALLING & INTERLOCKING SCHEMES & PLANS PREPARED.



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ELECTRO-PNEUMATIC,
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New Patent Electric Signal Controller and Replacer.

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ELECTRO-PNEUMATIC ROUTE INDICATING SIGNAL.

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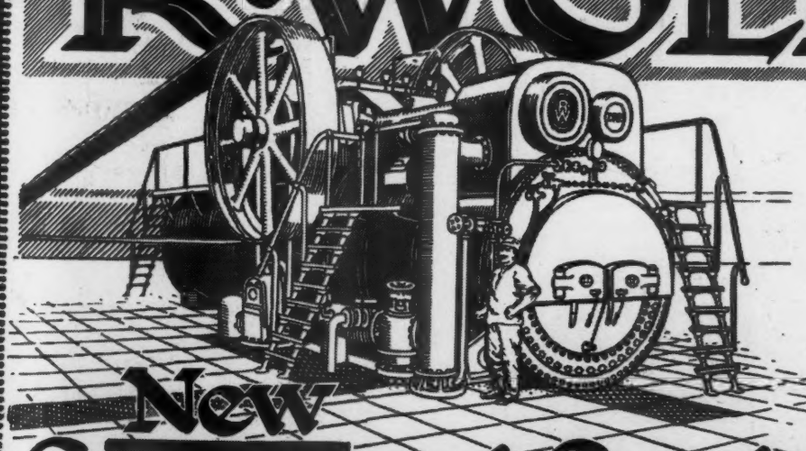
Telephone-London-Wall 7747.



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WOLF'S New Patent R.W.V. Valve Gear.

Separate Steam Inlet and Outlet Ports for BOTH Cylinders.
Positively Driven Piston Valves of Simplest Design
No Multiple Complicated Parts in the Valve Gear.

STEAM CONSUMPTION
attained on test by Prof. Doerfel:
8.9 lbs.
per Brake Horse Power per hour.

New
Compound Condensing
Superheated Steam Locomobiles
with R.W.V. Patent Valve Gear
The Last Word in
Up-to-Date Superheated Steam Engine Construction

Bailey's

"DAVIDSON" PATENT **STEAM PUMPS.**

**"THE PUMP WITH THE SIMPLEST SLIDE-VALVE."**

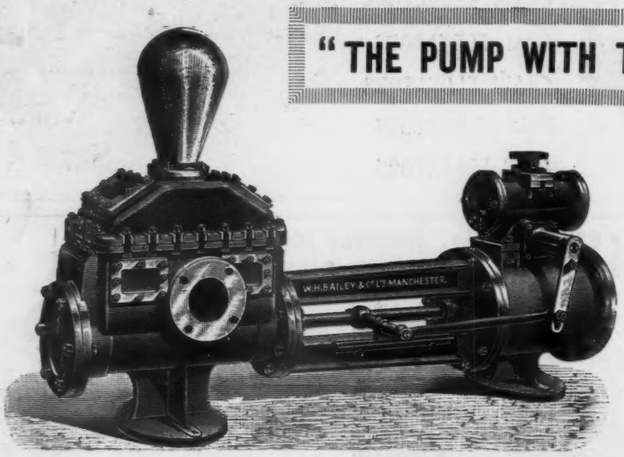



Fig. 1 D.—"DAVIDSON" STEAM PUMP, as made in the larger sizes.

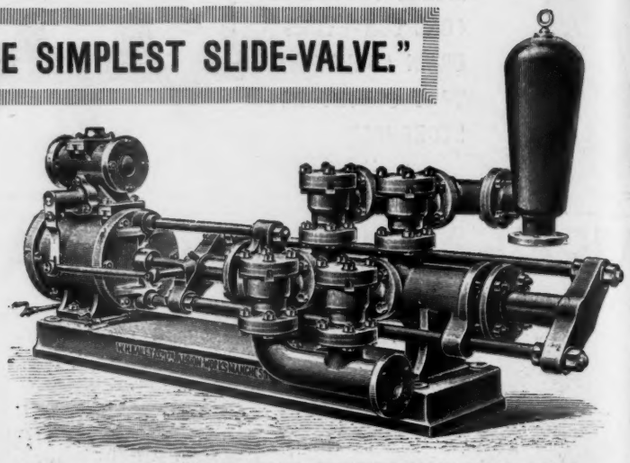
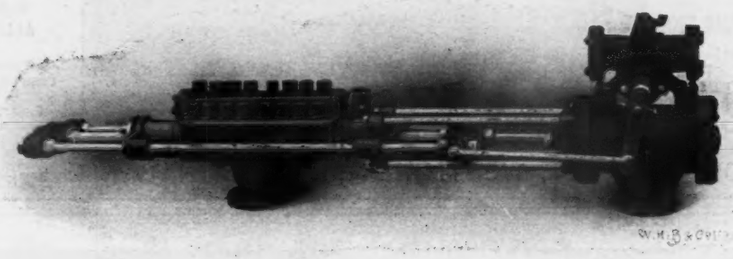


Fig. 6a D.—"DAVIDSON" HIGH-PRESSURE DOUBLE RAM PUMP.

Mechanical Cut-off.

Highest Economy yet attained.

Uses Less Steam than a Duplex Pump



Uses Less Steam than a Fly-wheel Pump.

Smoothest in Working.

Great Range of Speed.

Fig 6a D.—HYDRAULIC PRESSURE PUMP, 9in. × 2in. × 12in. size. Water Pressure, 1500 lbs. per sq. in.

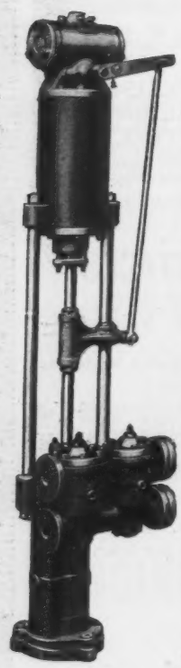


Fig. 50 D. "DAVIDSON" ECONOMICAL BOILER FEED PUMP.

See our Exhibits at the Colliery and Mining Exhibition, Manchester, Stand No. 48, June 12-27, 1914.

Fig. 15 D.—"DAVIDSON" PATENT INDEPENDENT AIR PUMP AND JET CONDENSER.

For Stationary Engines, Lake, River, and Canal Steamships, &c.

RAISES WATER FOR CONDENSING AND :: GIVES A VACUUM OF 27 INCHES.

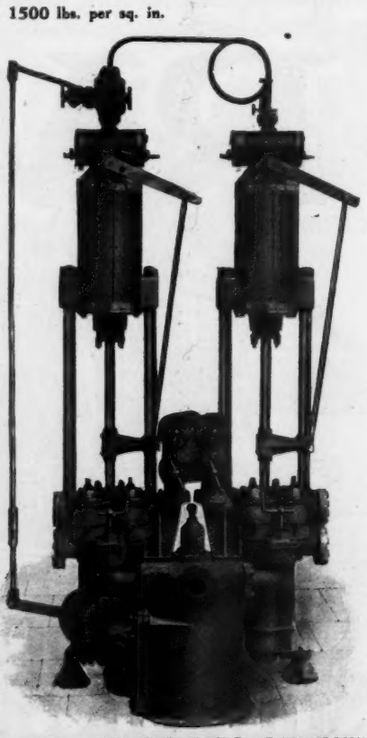


Fig. 50 T D.—SET OF BAILEY'S "DAVIDSON" BOILER-FEED PUMPS, as supplied to the Prince Line, Ltd., Newcastle-on-Tyne.

*Manufactured by*

C2210

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## LONDON:

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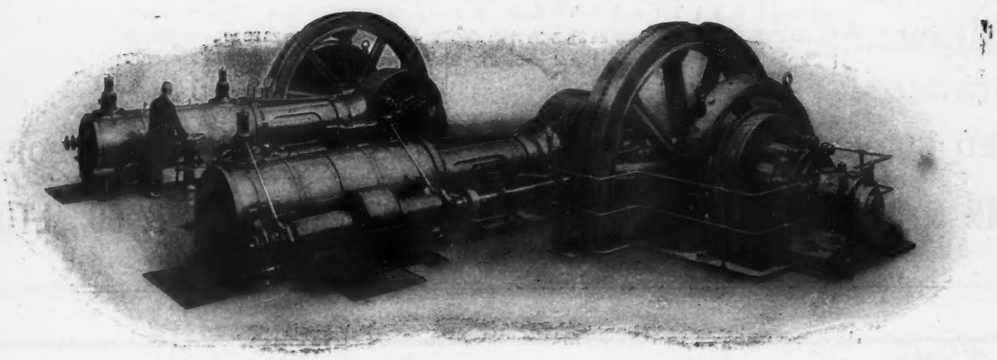

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## SULZER UNI-FLOW STEAM ENGINES

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Alternating-flow Steam Engines; Steam Boilers of all systems; Four- and Two-stroke cycle Stationary Diesel Oil Engines; Directly Reversible Marine Engines; High-, Medium-, and Low-Lift Centrifugal Pumps; Sinking Pumps; Pumps for Fire Extinguishing purposes; Fans of all kinds; Ice and Refrigerating Machinery; Heating Installations.

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## PATENT HIGH-SPEED COMBINED SURFACING, BORING, MILLING AND DRILLING MACHINE.

## INDISPENSABLE TO EVERY MACHINE SHOP.

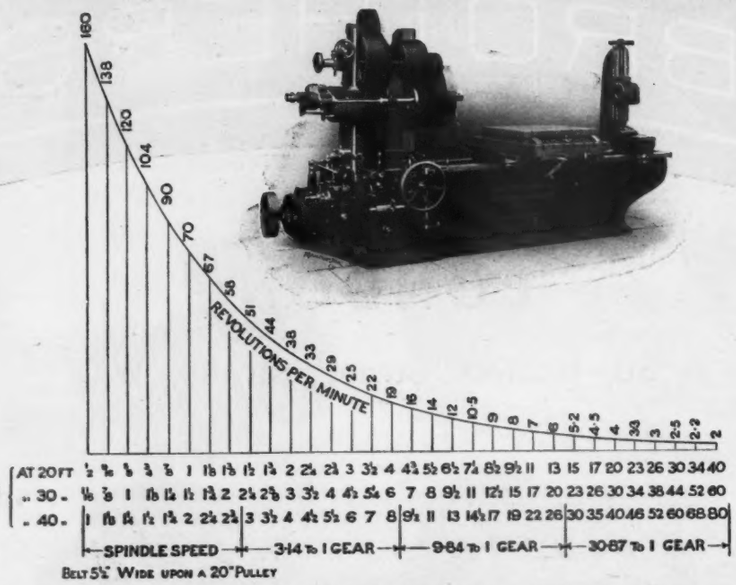
**32** Spindle Speeds with increased Cutting Power.

**Combination** of Single Belt and Gear Drive to the spindle, this guarantees Silent Running.

**Speed** and Feed Gearing as well as the Self-adjusting Friction Clutches run in Oil Baths, and are readily accessible without the removal of any other parts of the machine.

**Rapid** Power Traverse to all motions.



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**Interlocking** Levers for Speed and Feed changing.

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**The Bed** is carried down to the floor. The cuttings are discharged at the back of the machine.

**No Bolting** to foundations necessary.

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RECIPROCATING ENGINE & EXHAUST TURBINE
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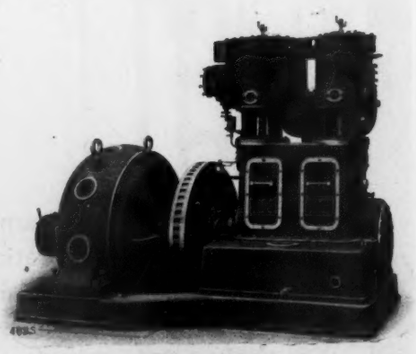

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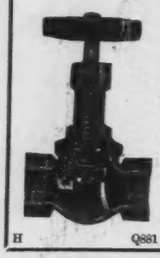

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"CROWN" ASBESTOS & MAGNESIA.
As Used by H.M. Govt. Depts.
"CROWN" TELLURIC CEMENT.
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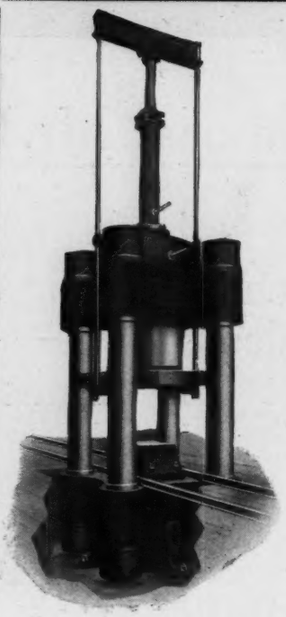

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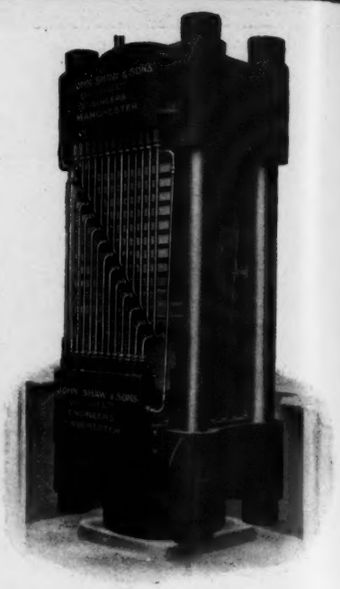

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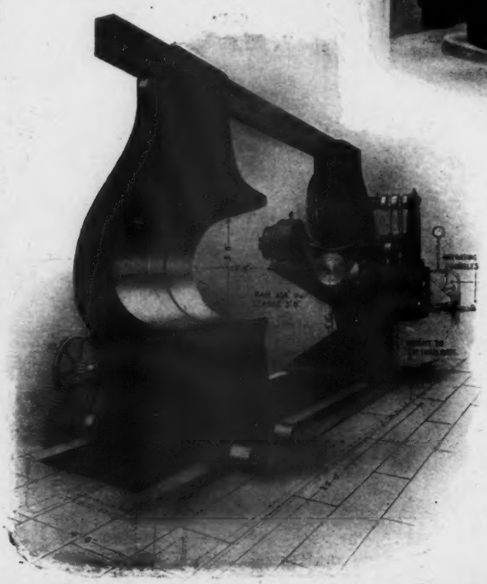

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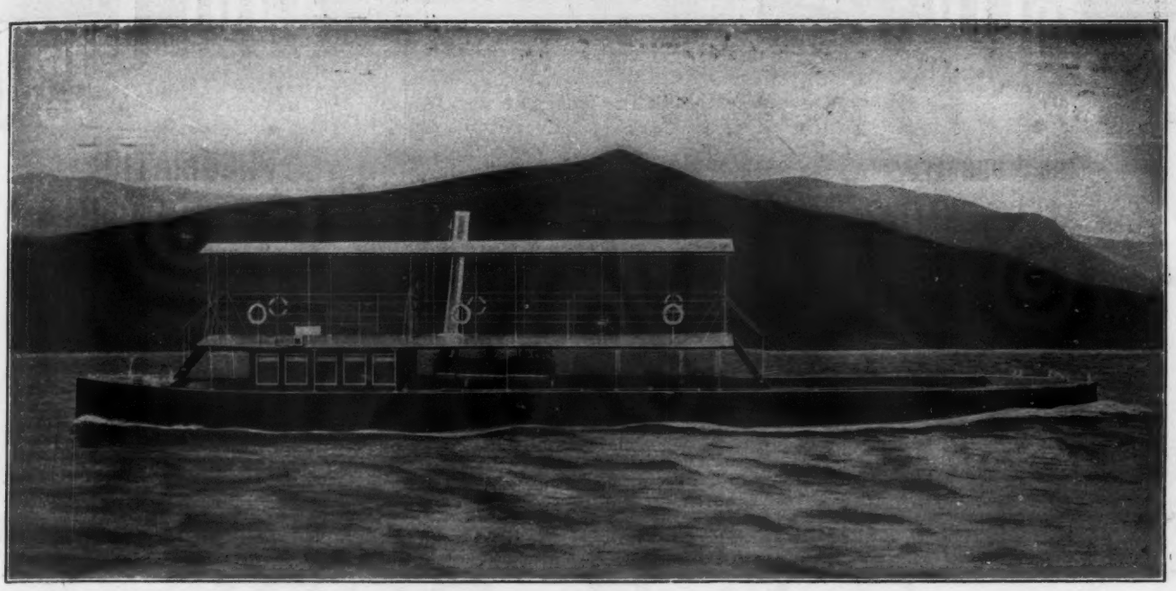

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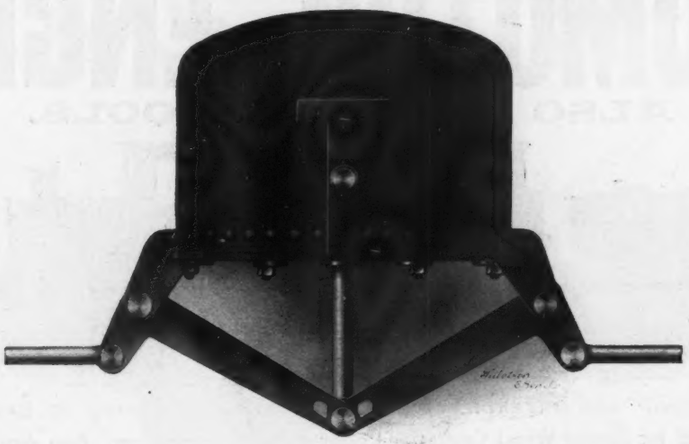

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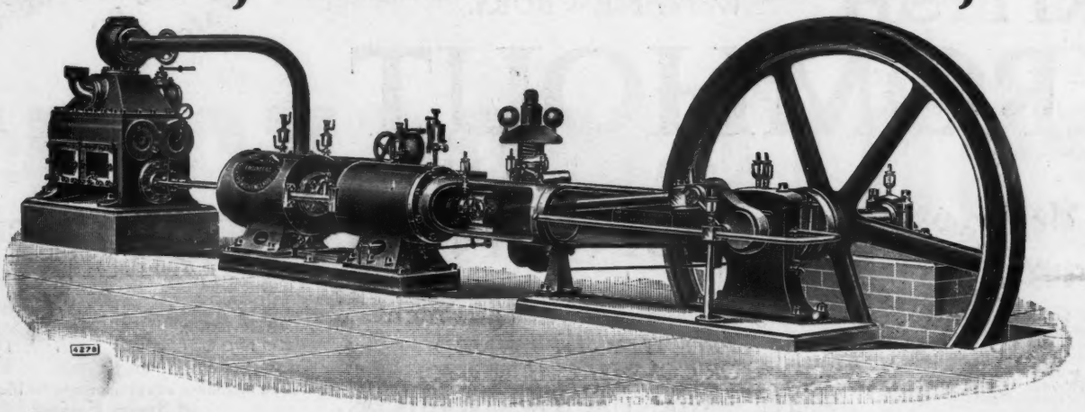

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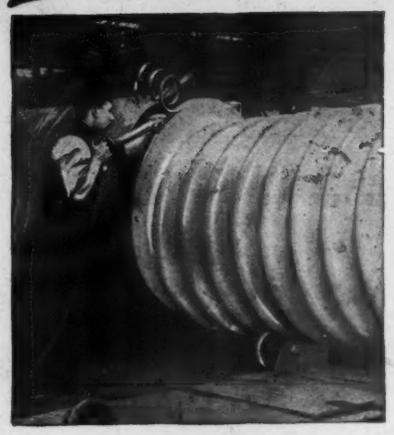

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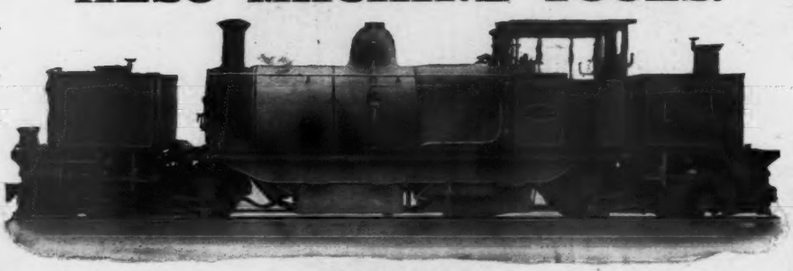

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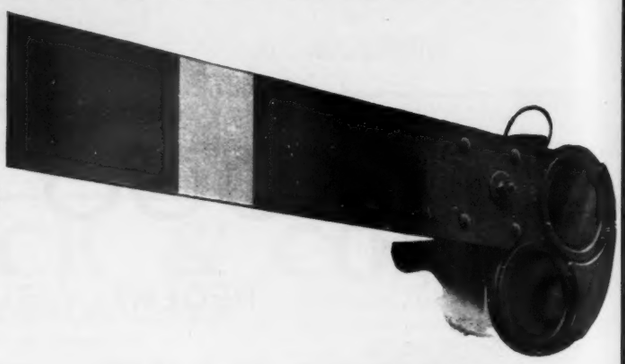

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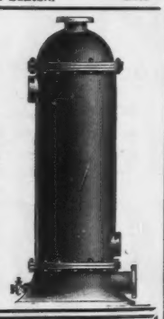

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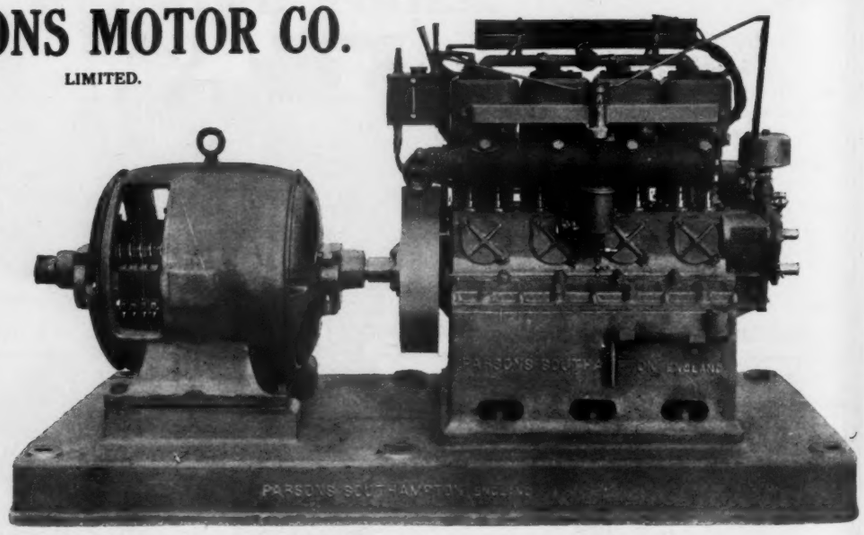

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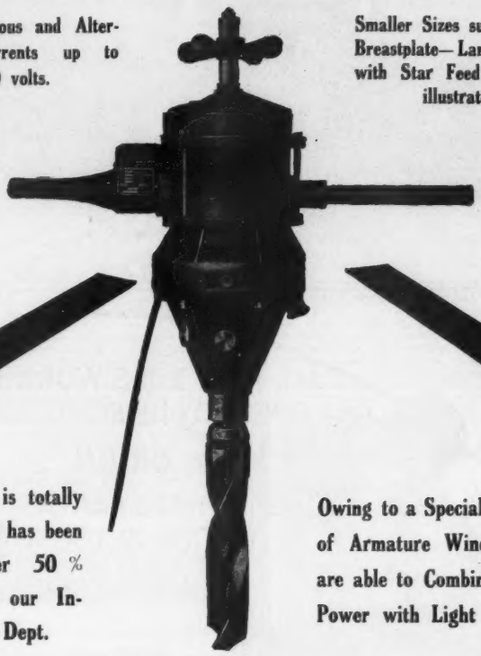

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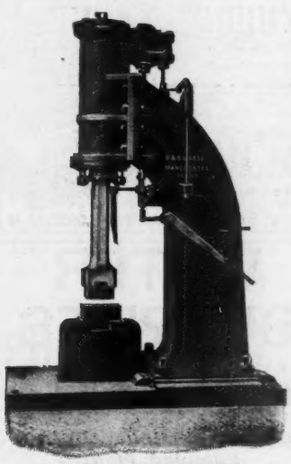

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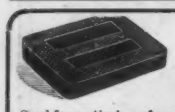

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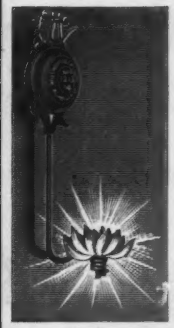

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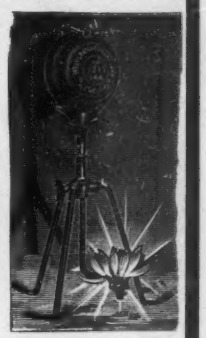

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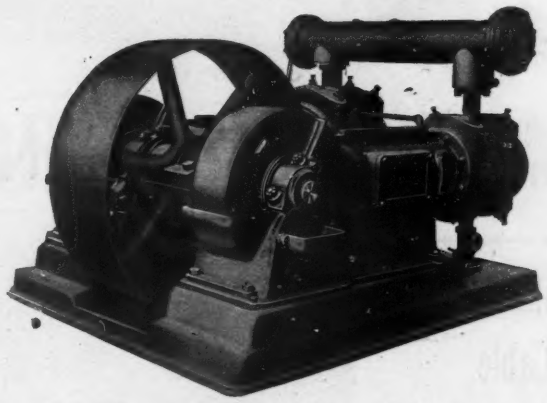

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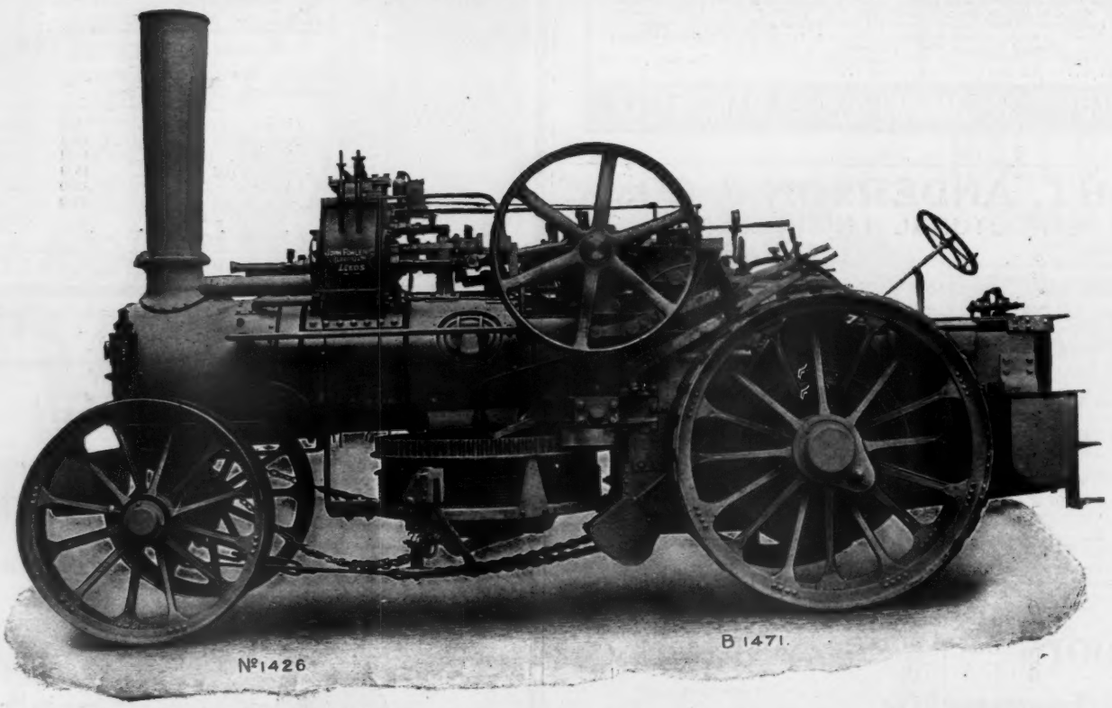


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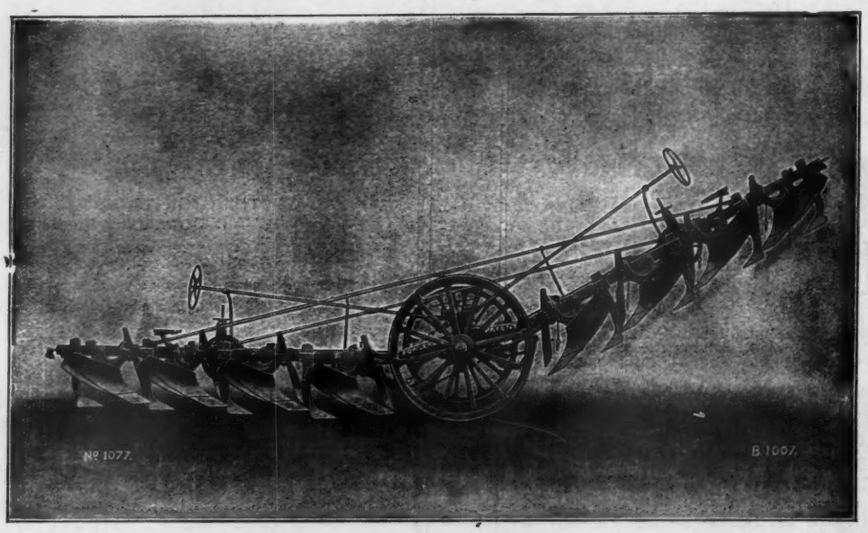


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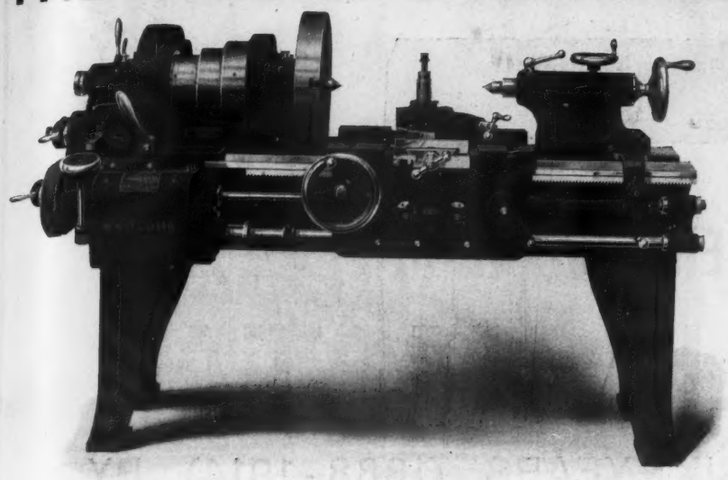

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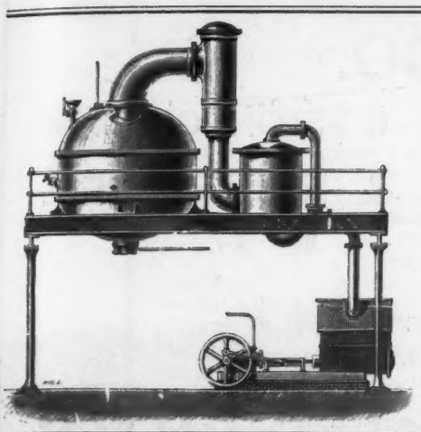

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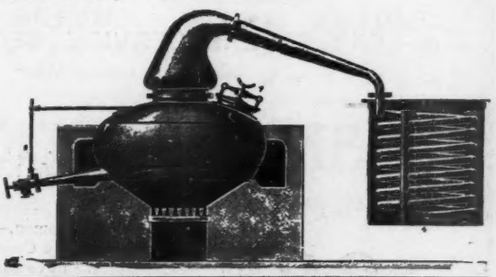

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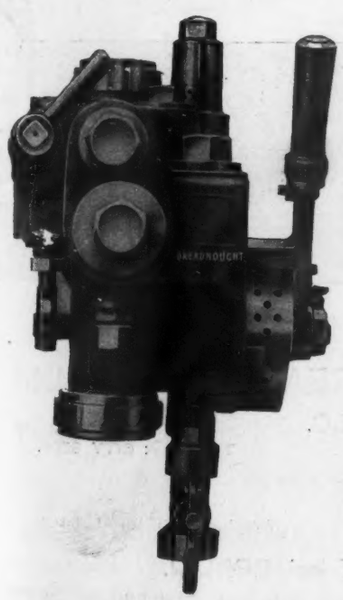

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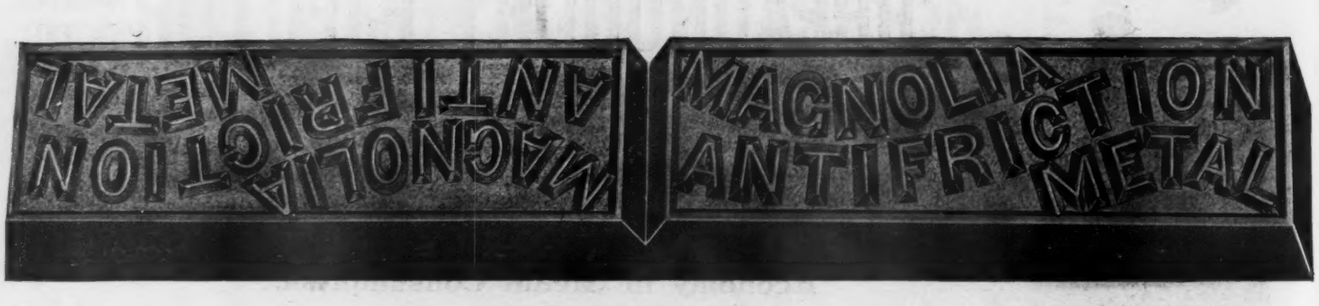


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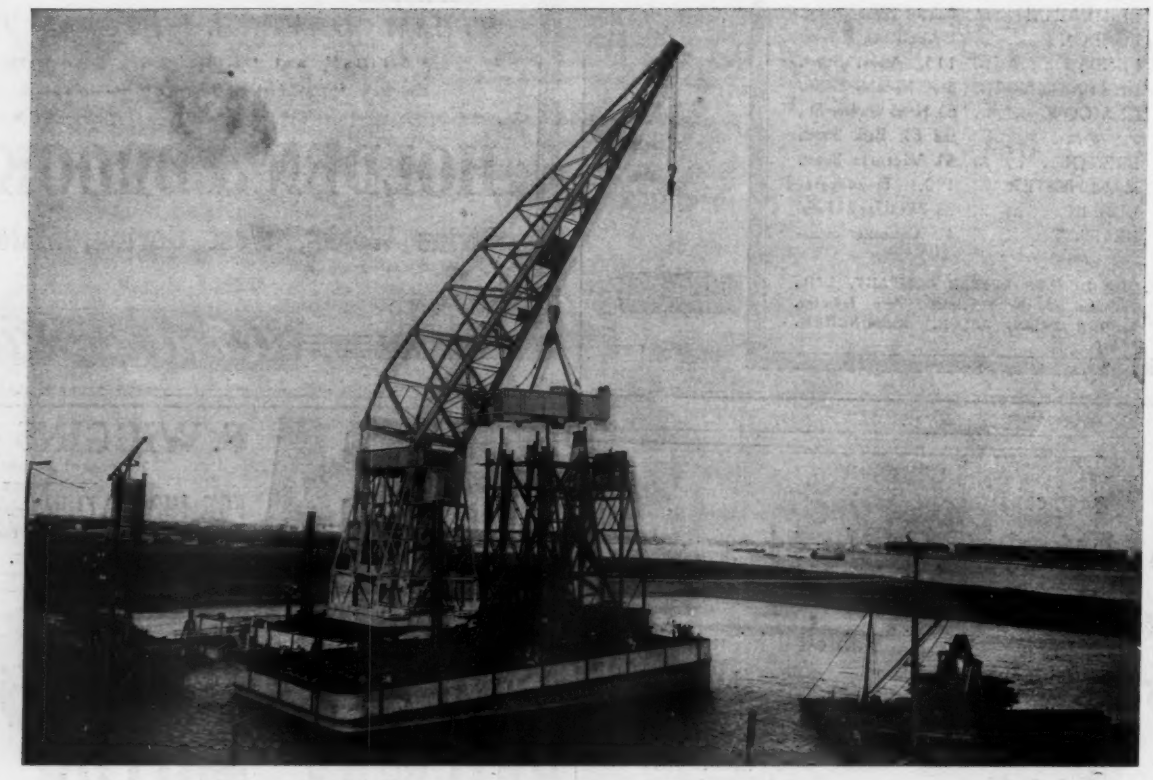

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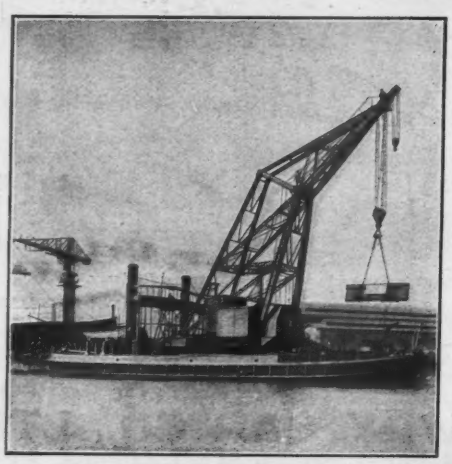

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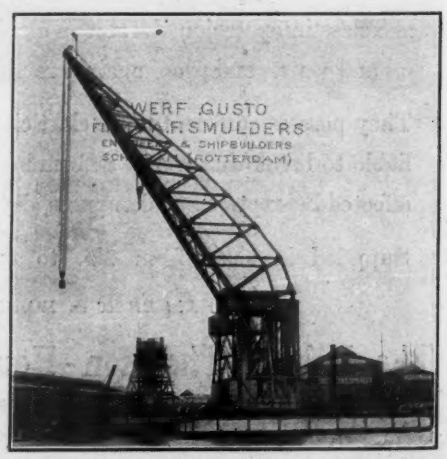


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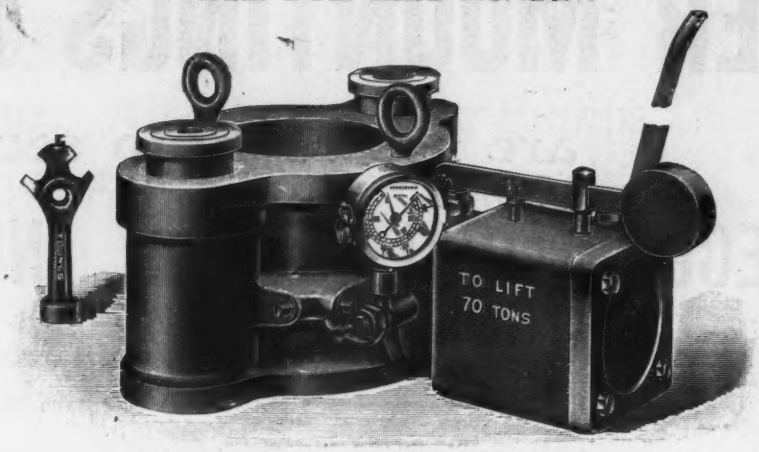


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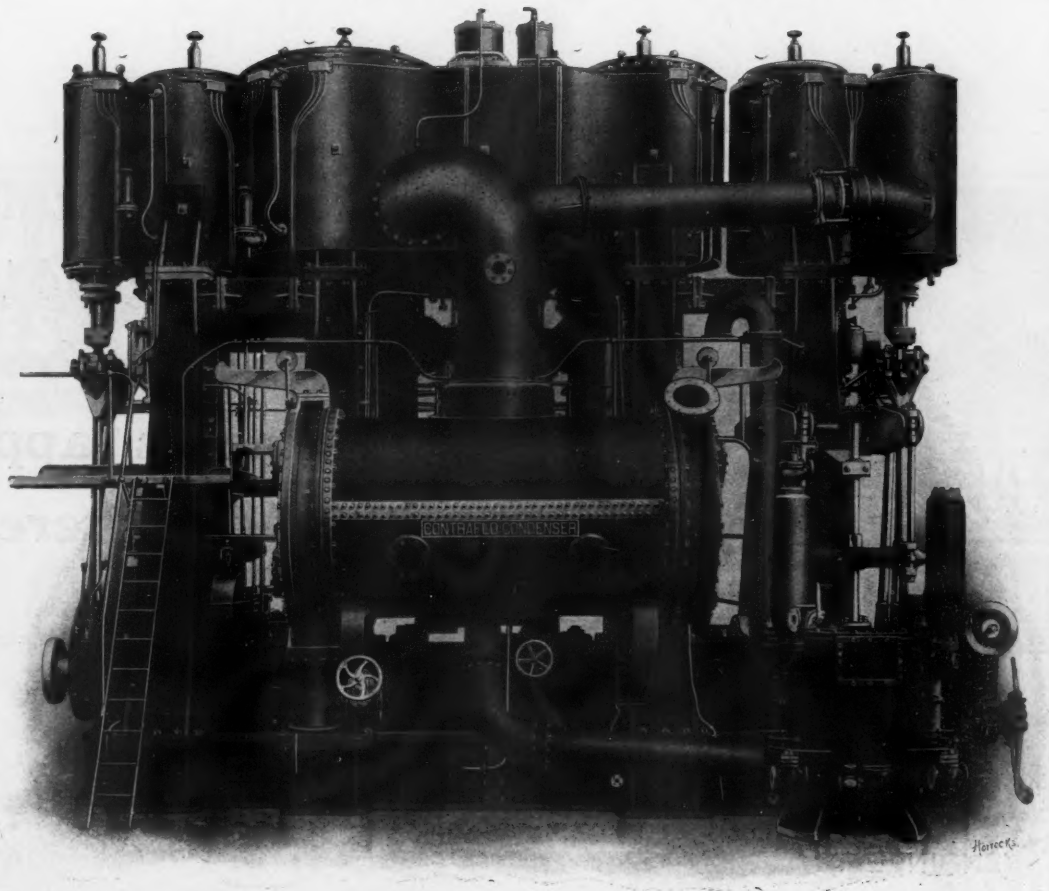


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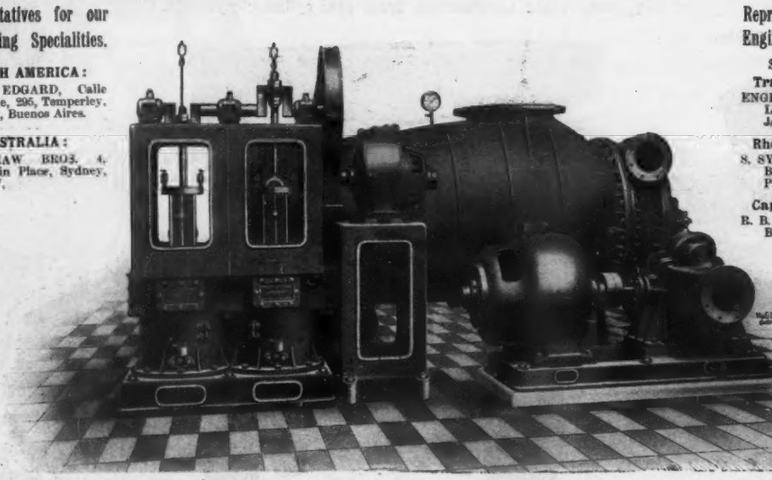

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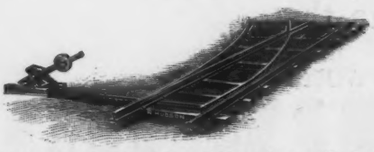

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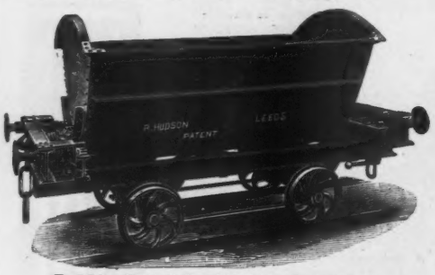

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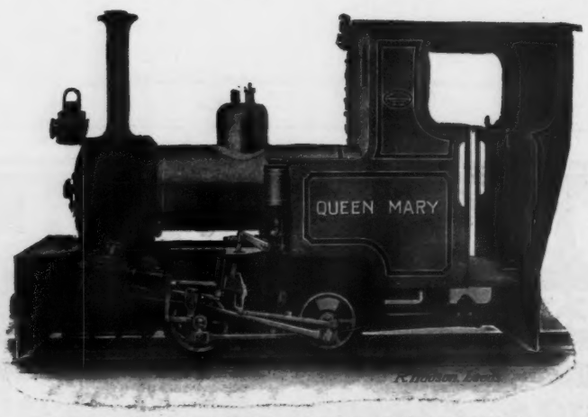


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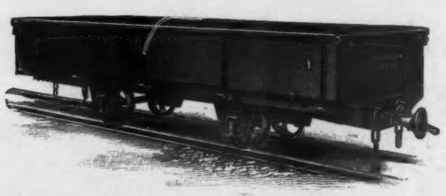

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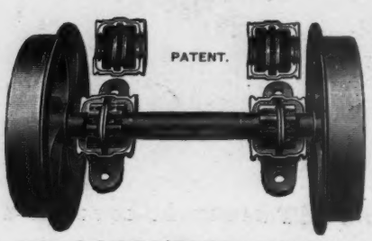


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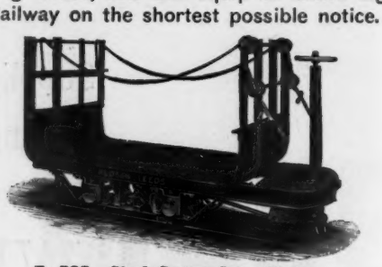

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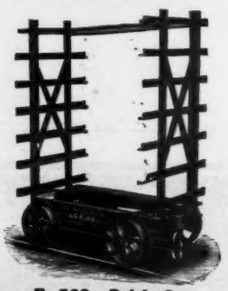

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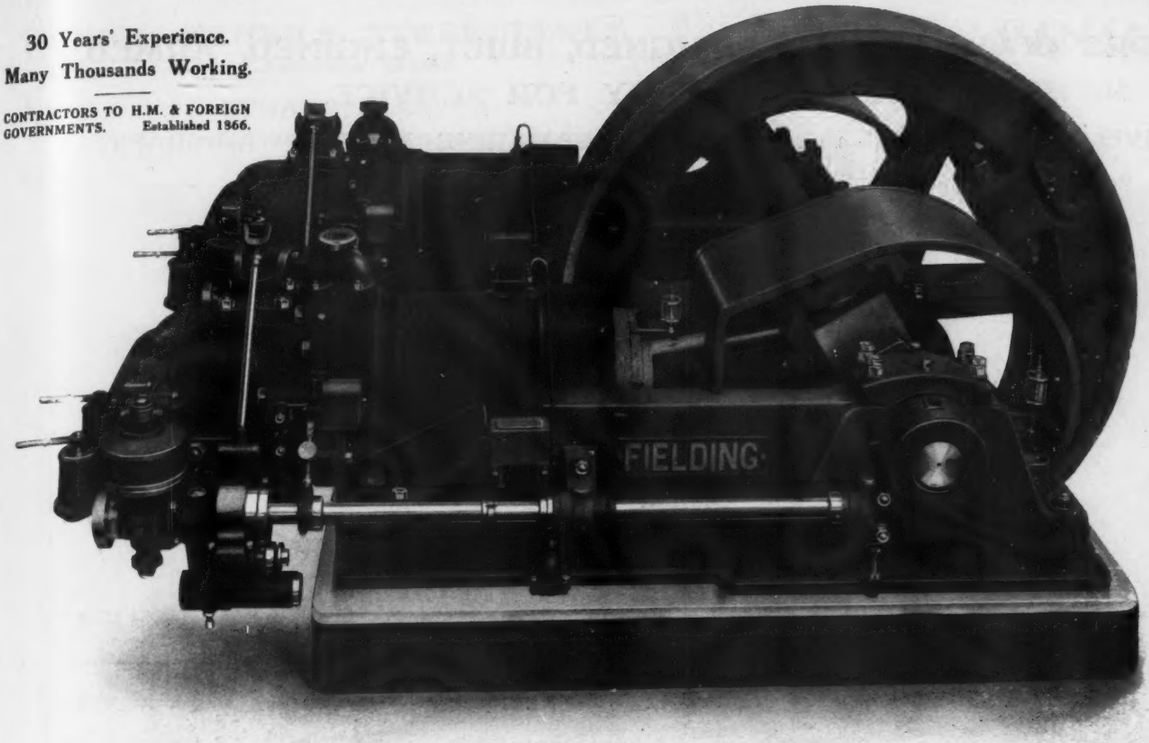


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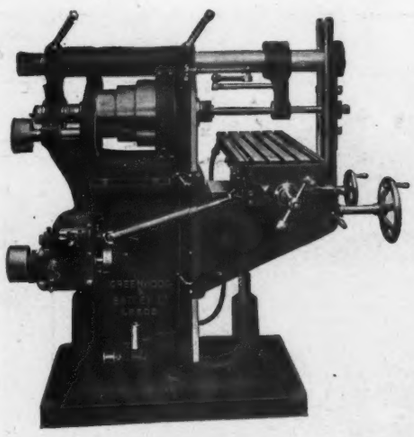

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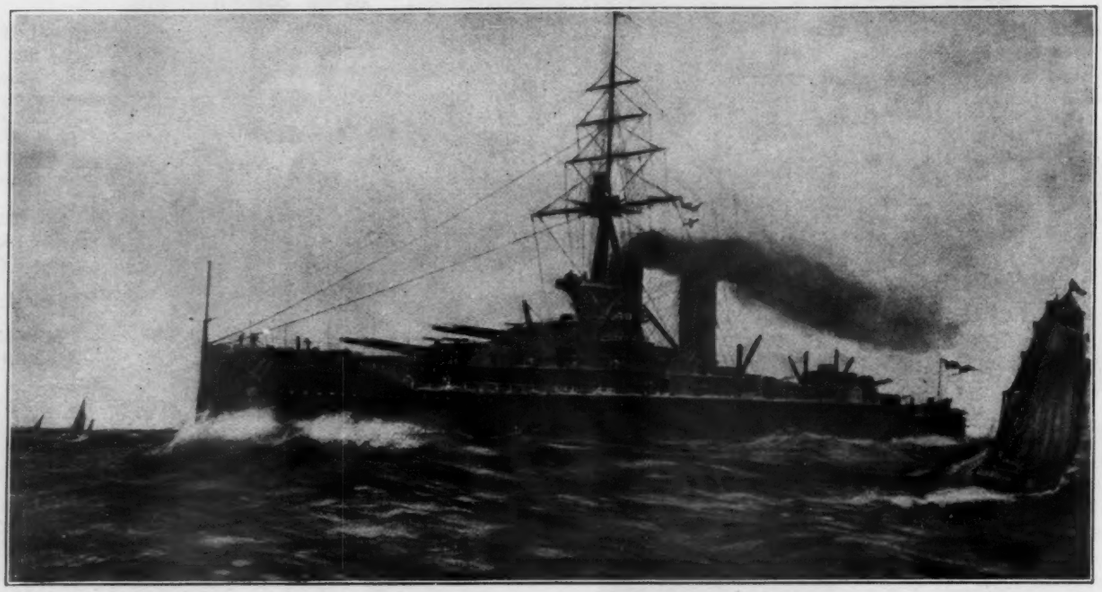

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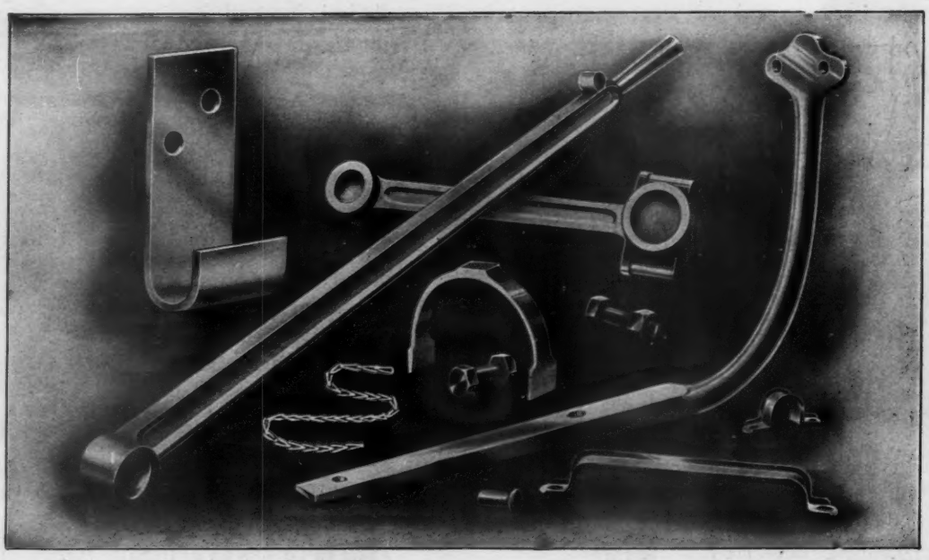

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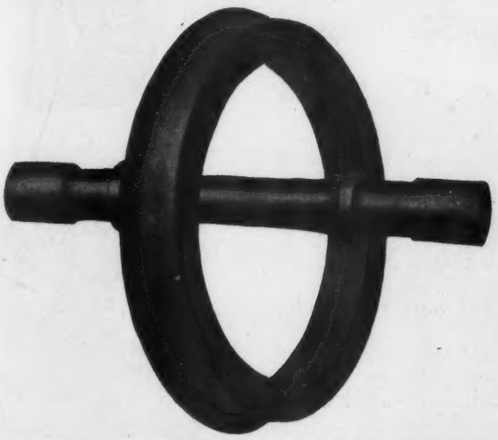

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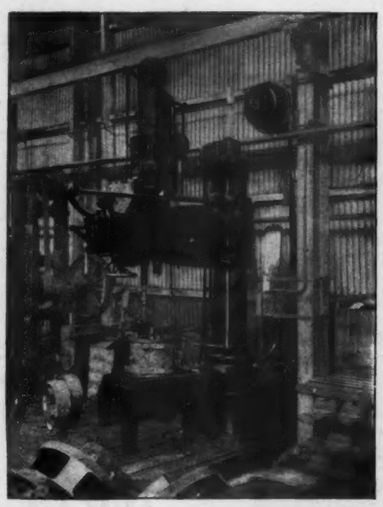

The illustration shows a Vickers' motor driving drilling machine in modern engineering shops in Midlands. Motor, 5 H.P., 460 volt, 550 r.p.m. Radial machine, 3ft. 6in., drills holes up to 2in. diameter.

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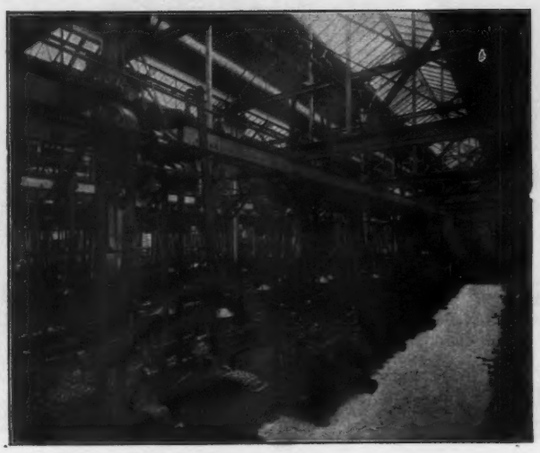

The Twist Drill Section, Erith Works.

## ADJUSTABLE REAMERS

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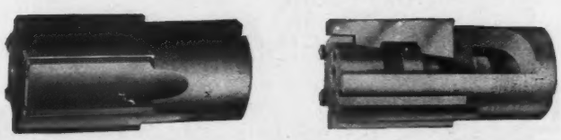

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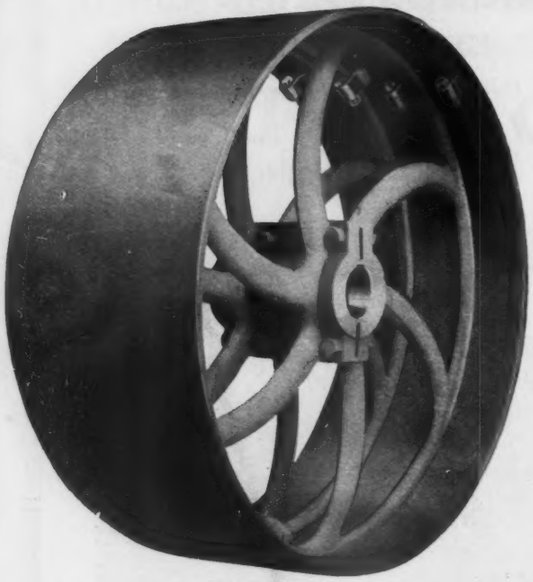

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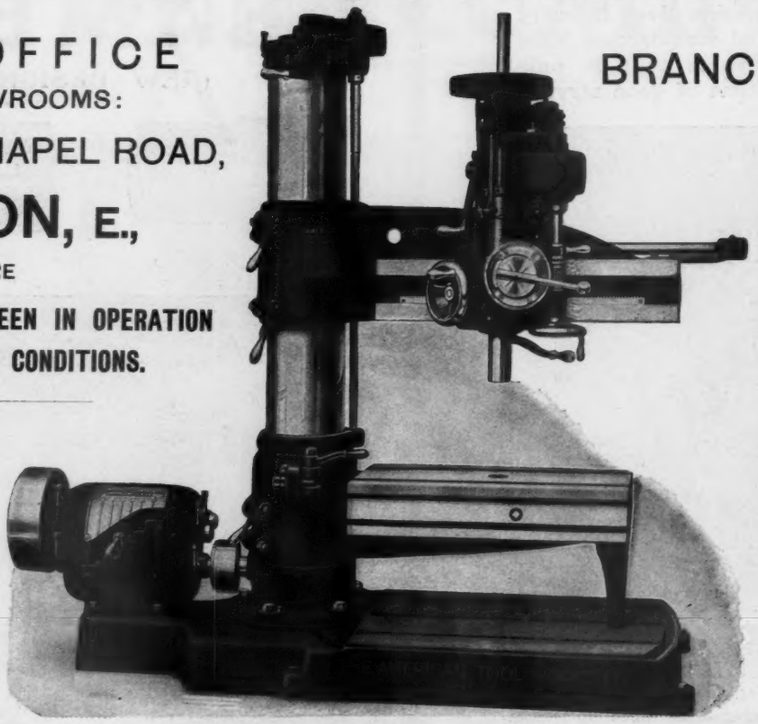

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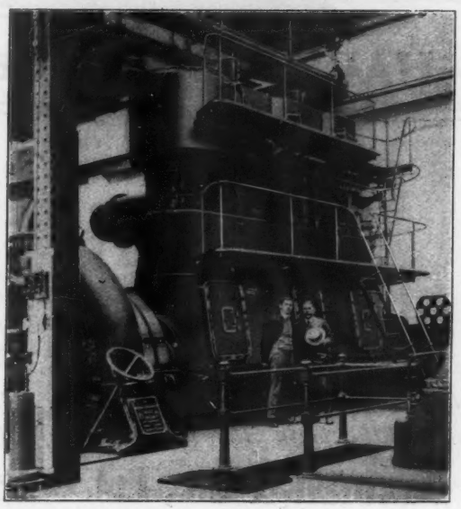

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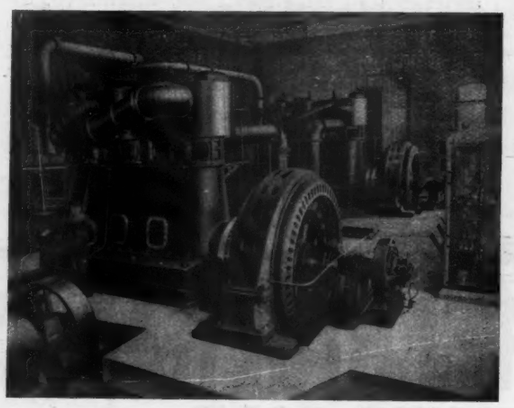

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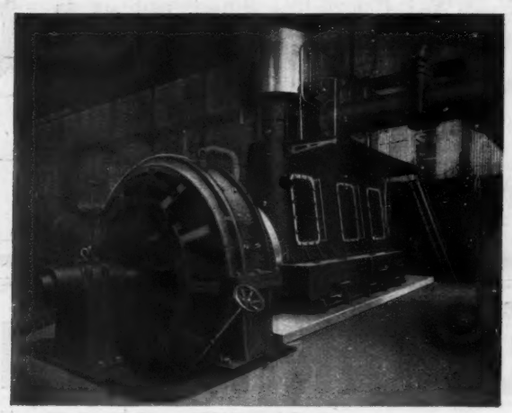

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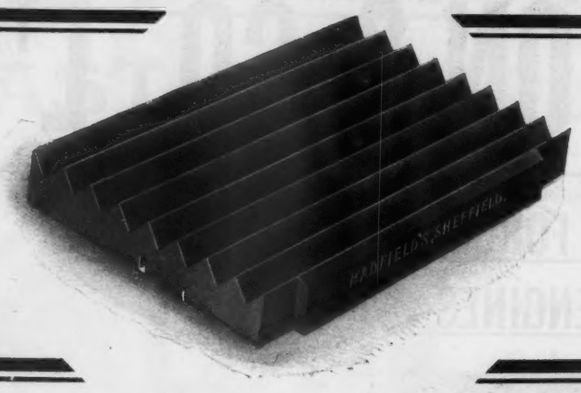


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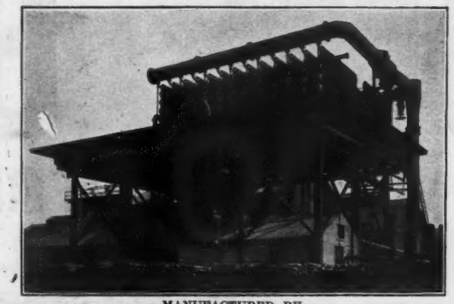
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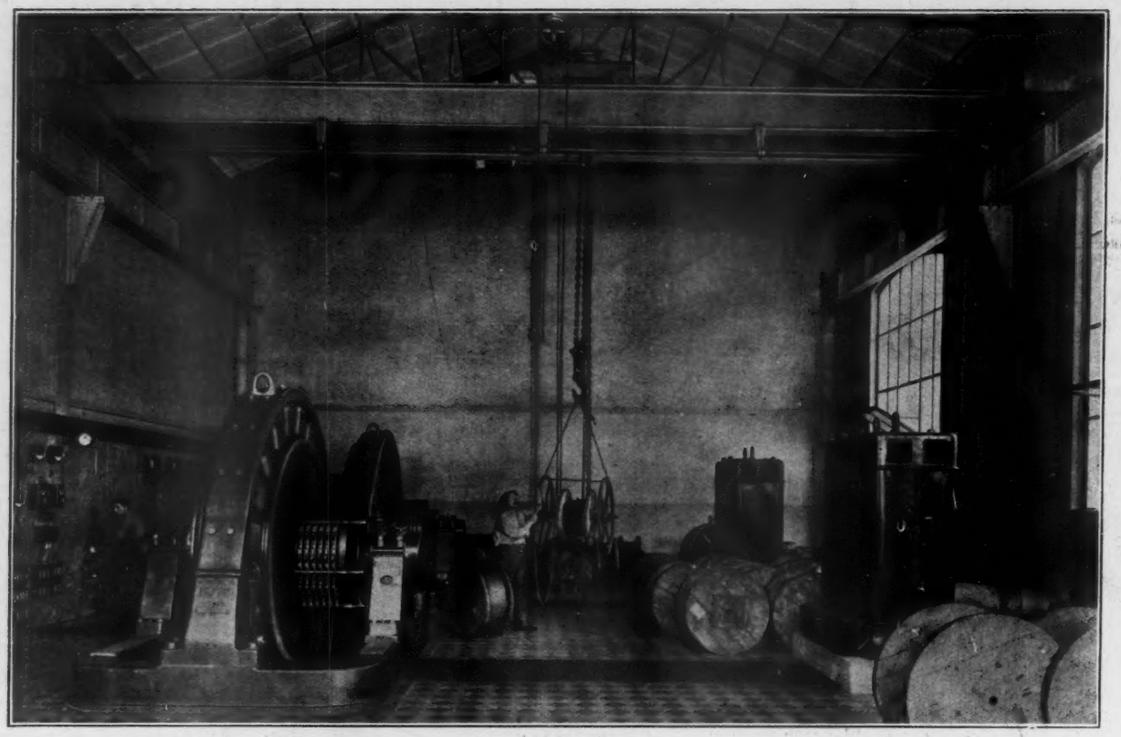

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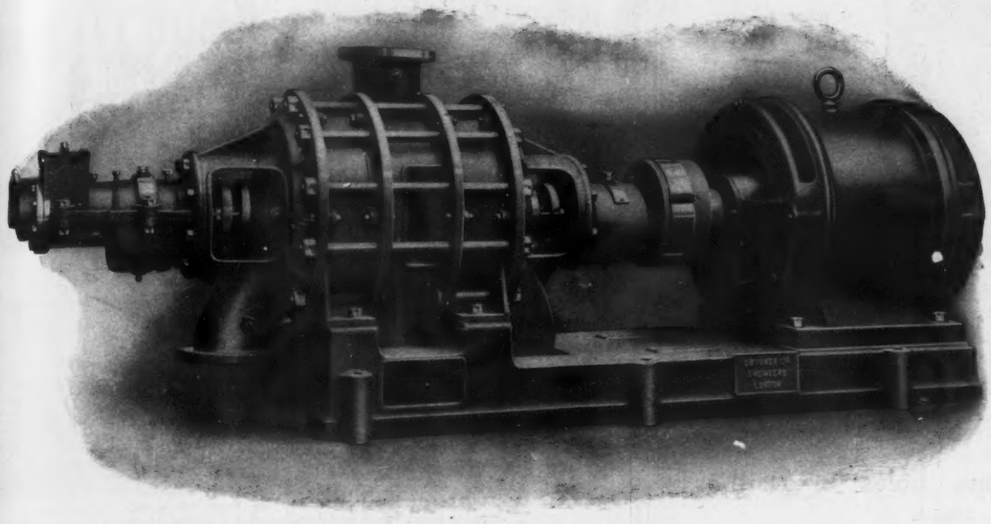

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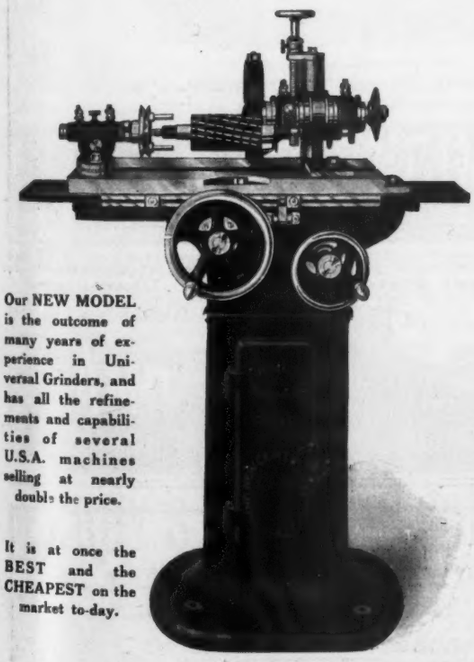

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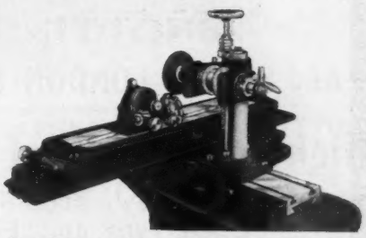

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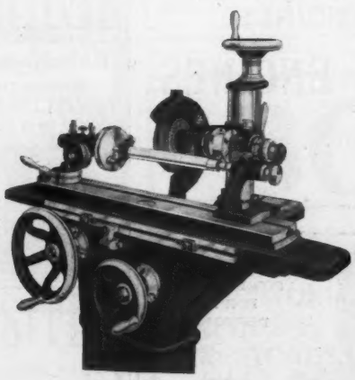

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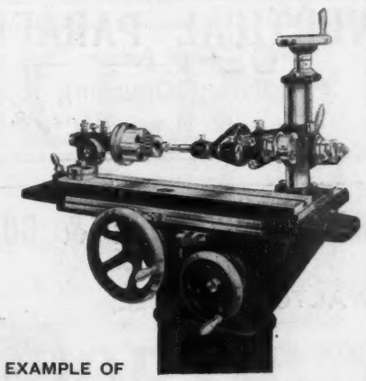

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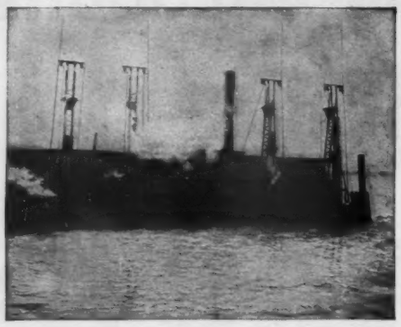

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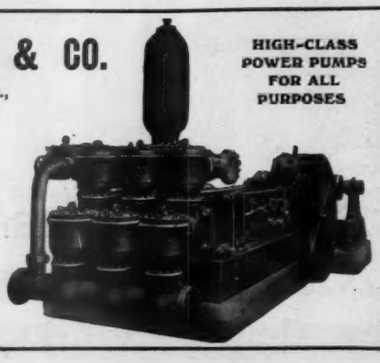

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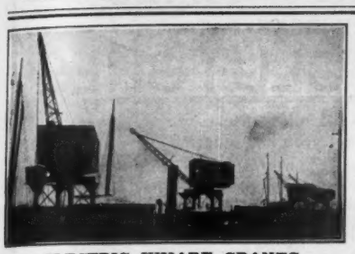

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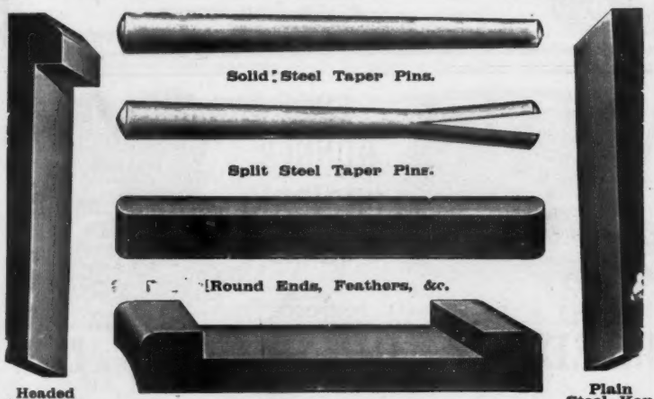


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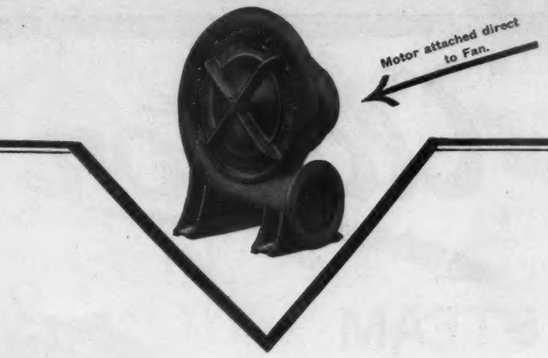


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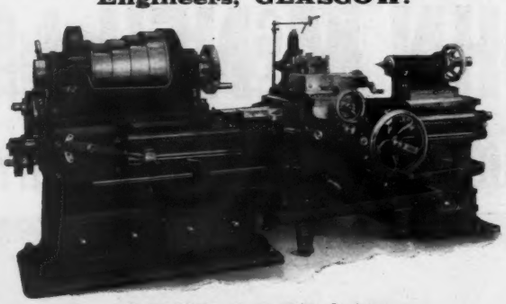

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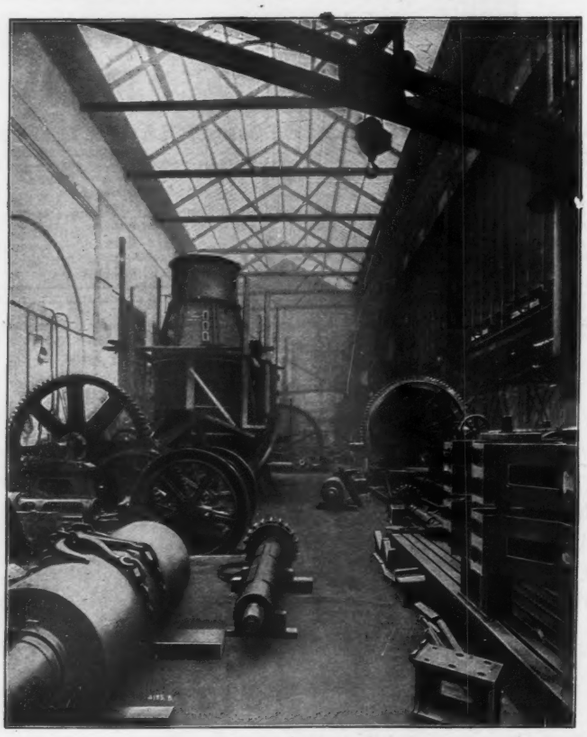

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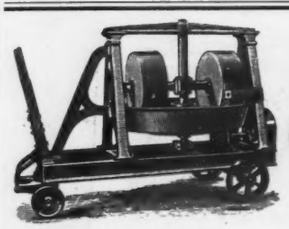

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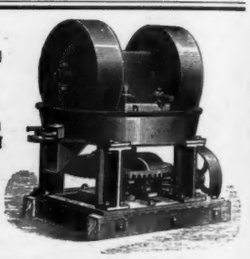

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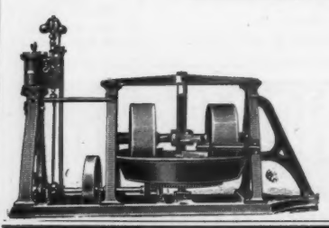

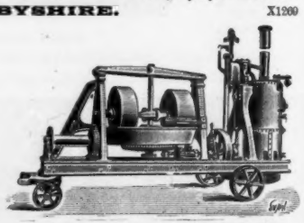

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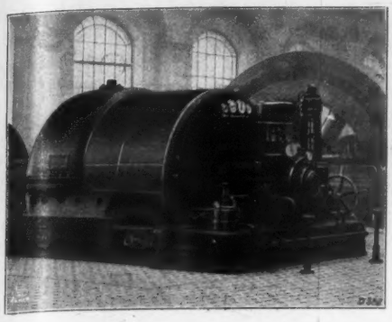

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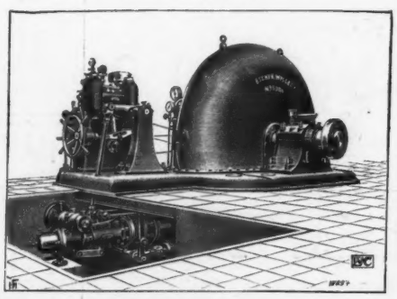

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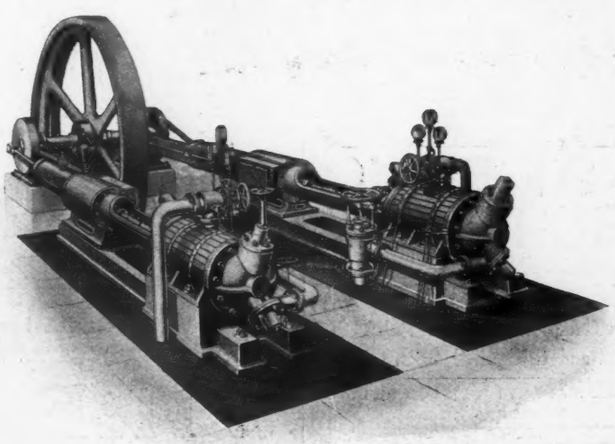

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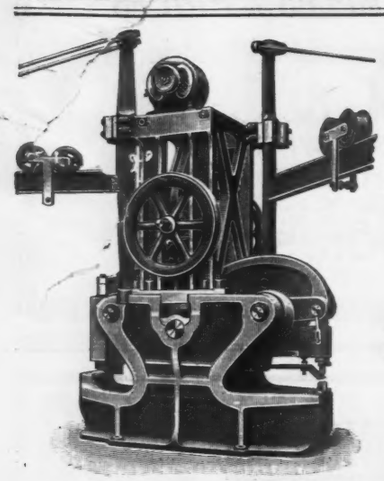

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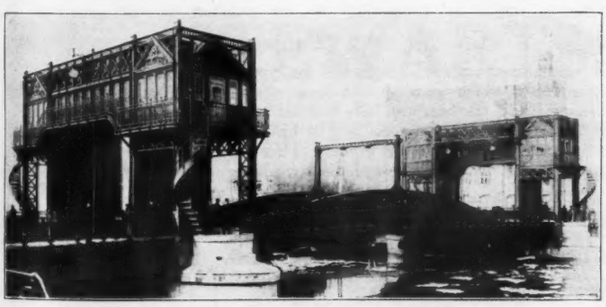

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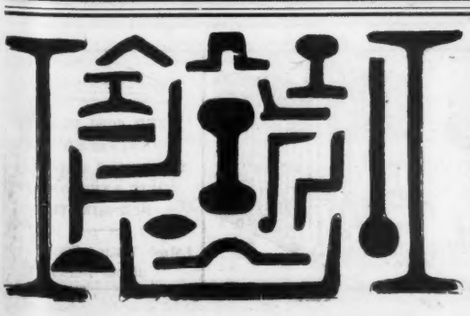

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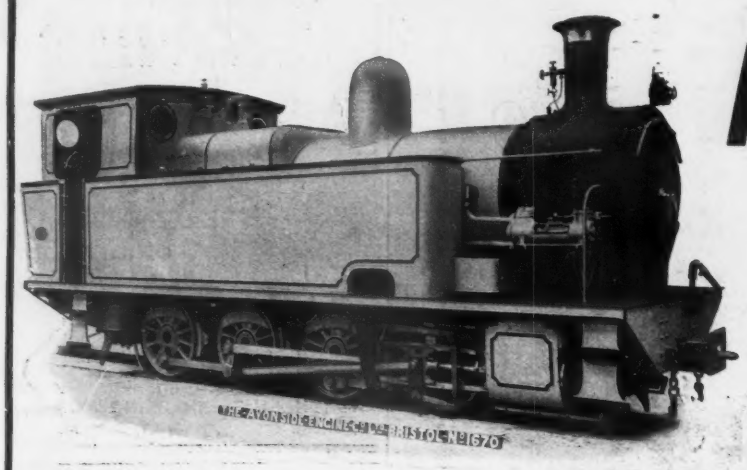

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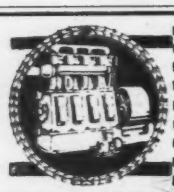

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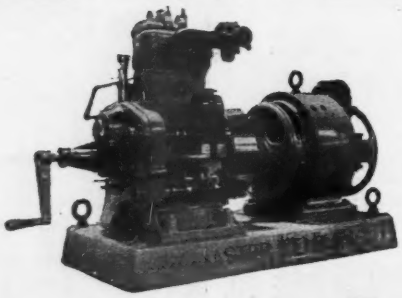

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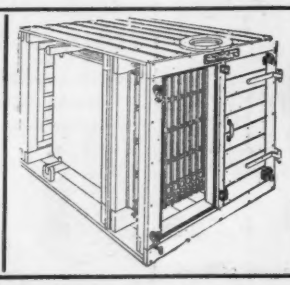

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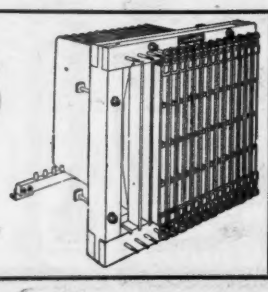

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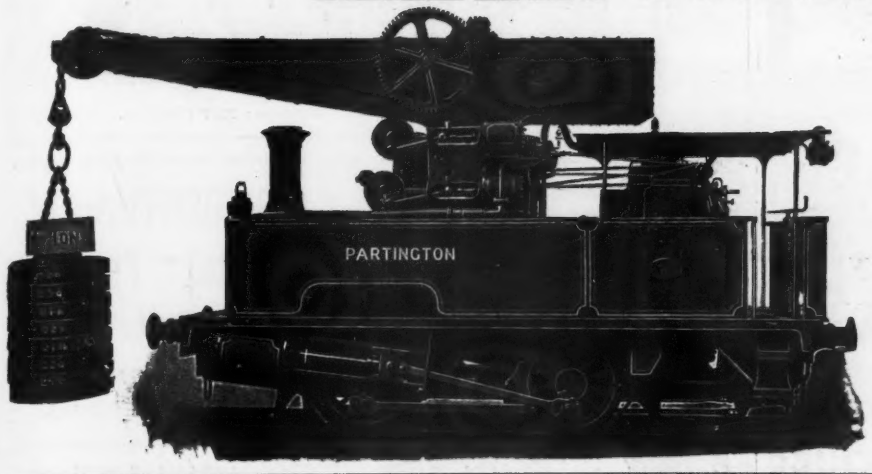


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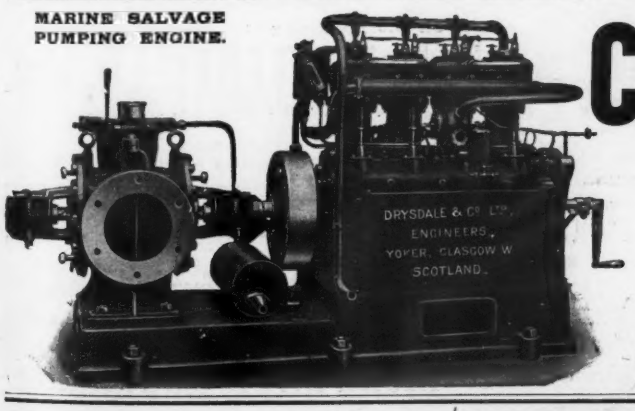


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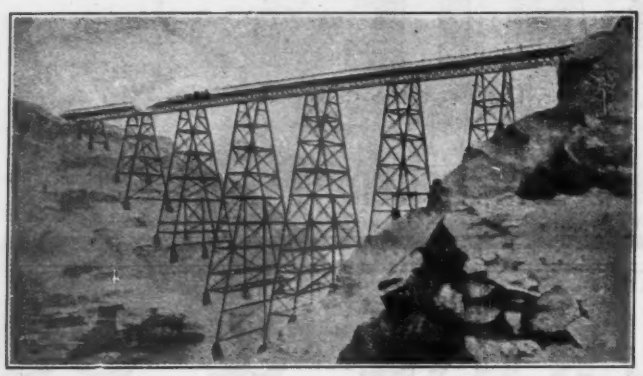

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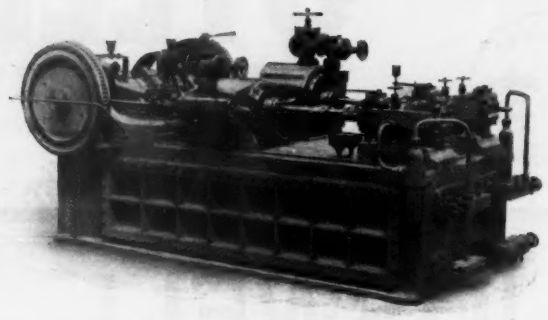

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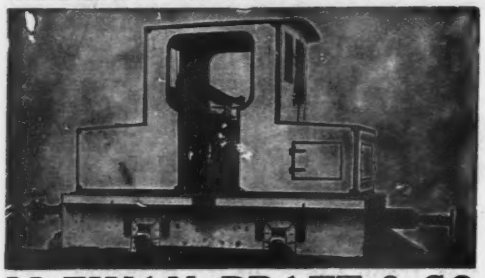

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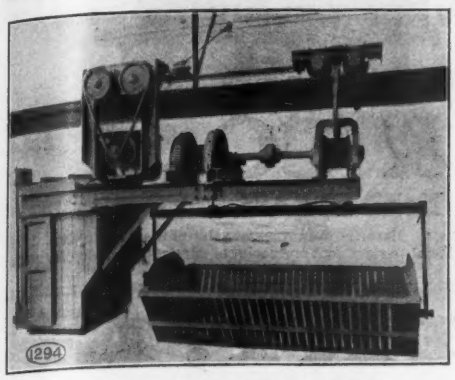


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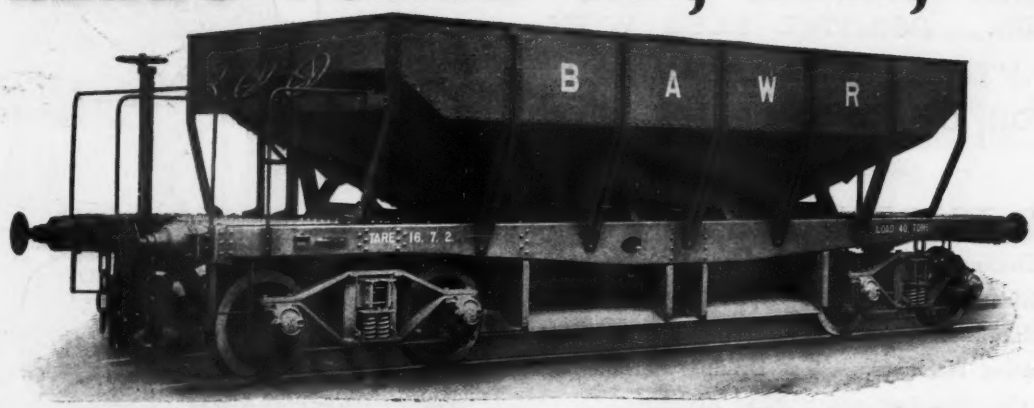


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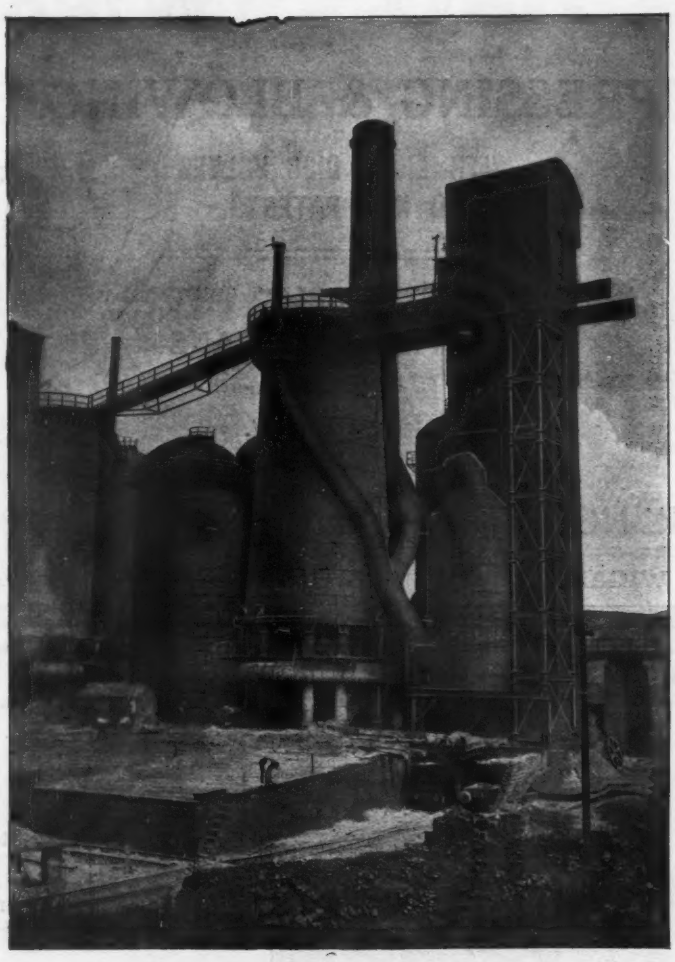

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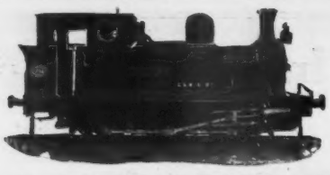
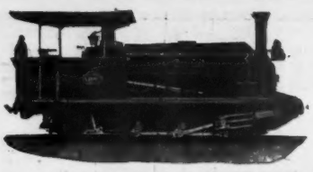
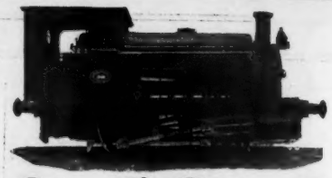

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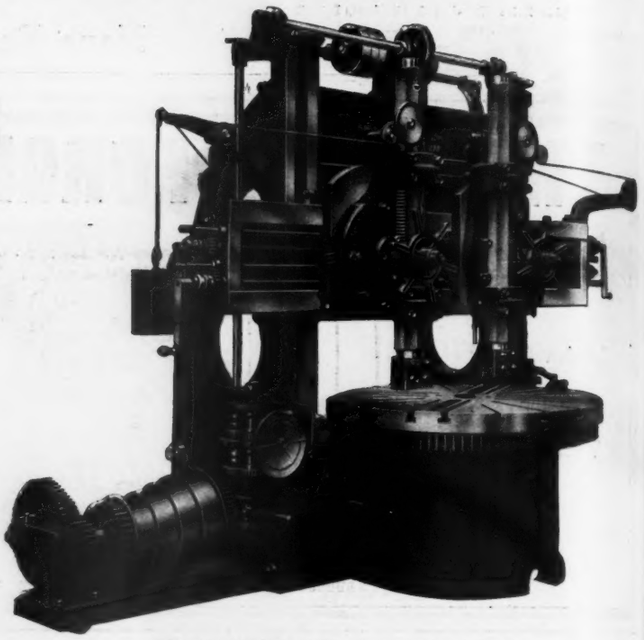

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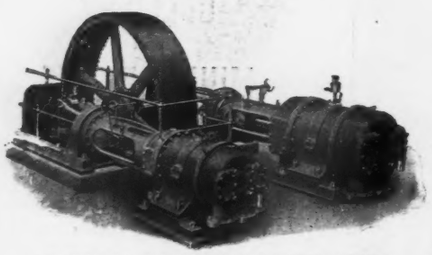

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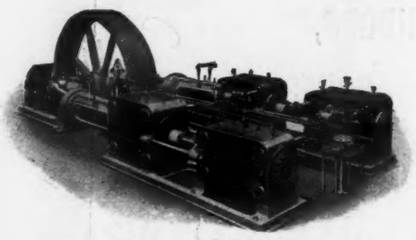

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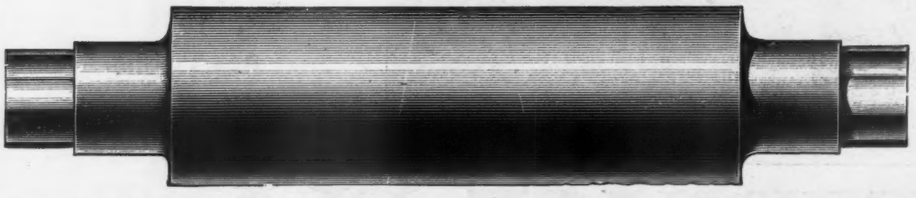

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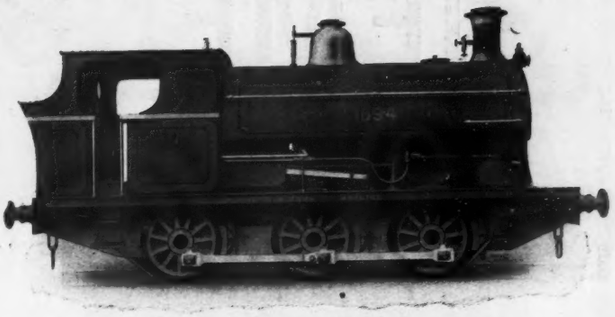

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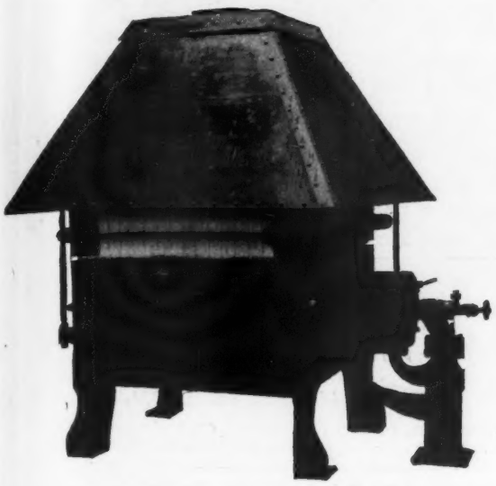

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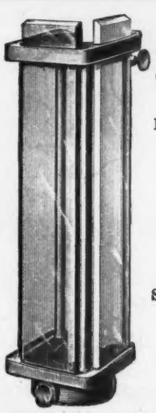

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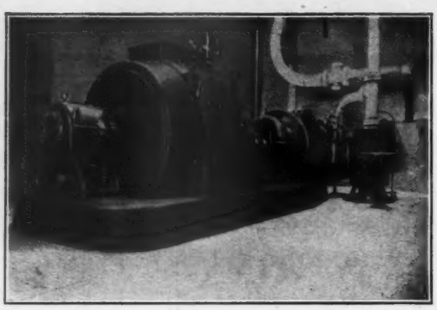

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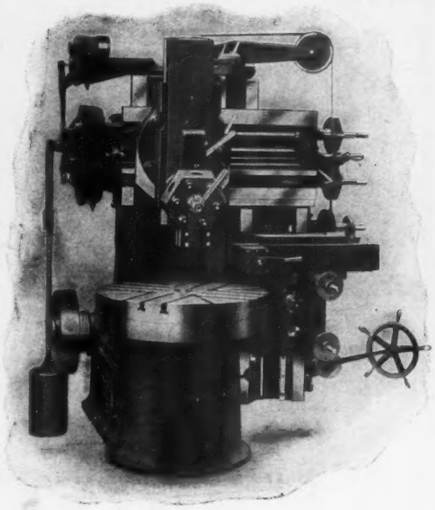

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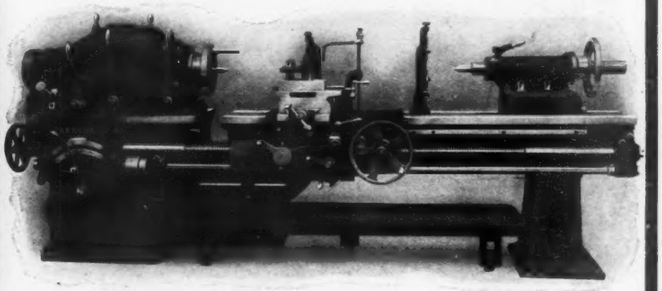

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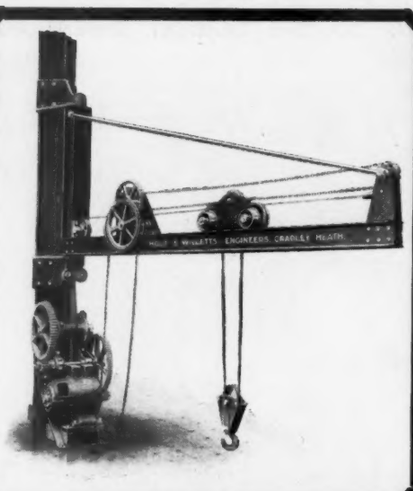

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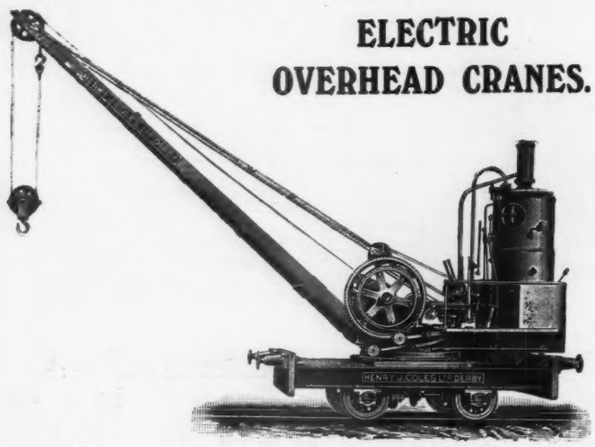

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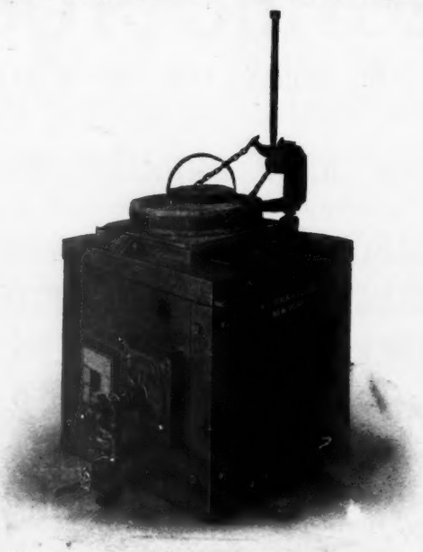

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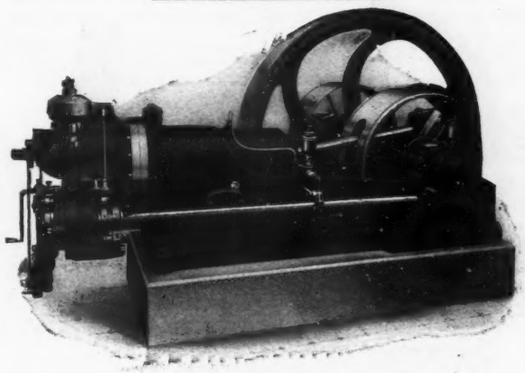

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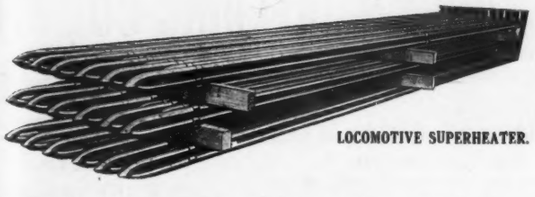

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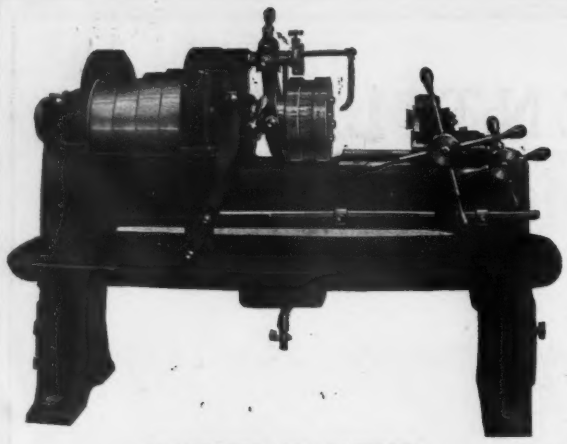

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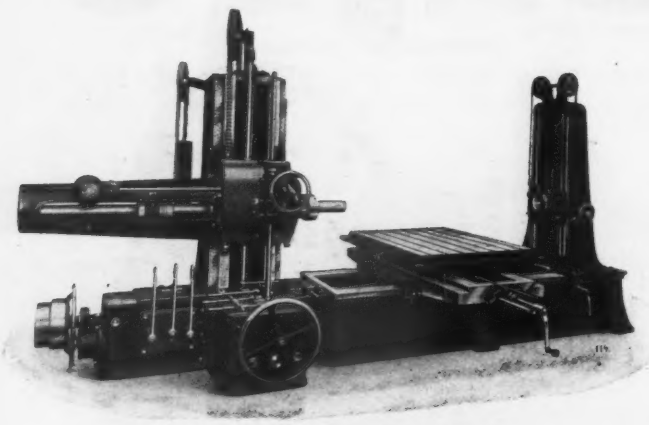

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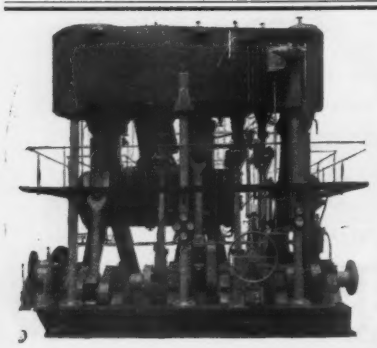

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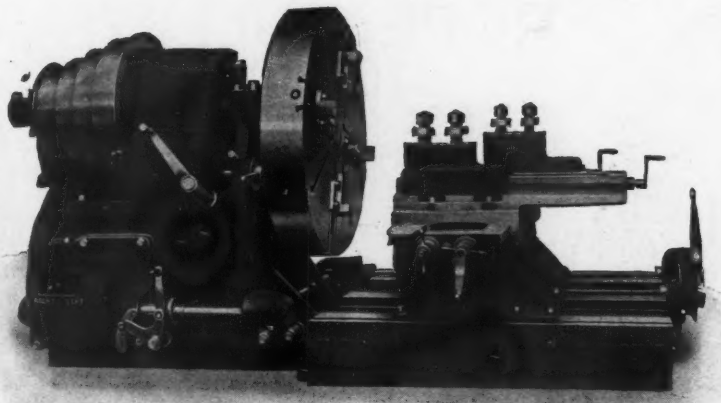

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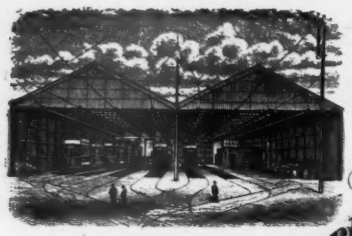

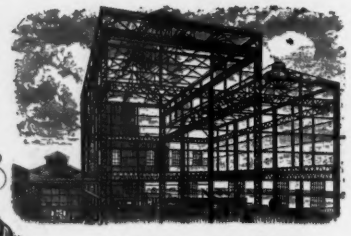

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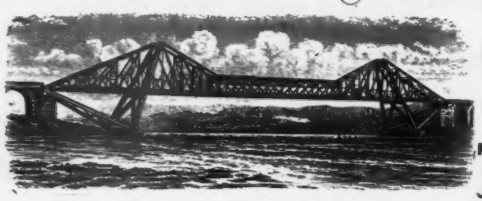

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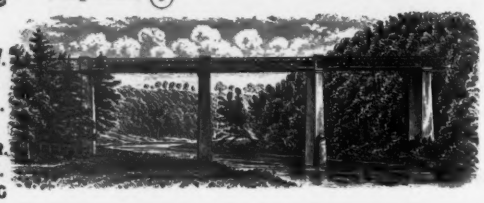

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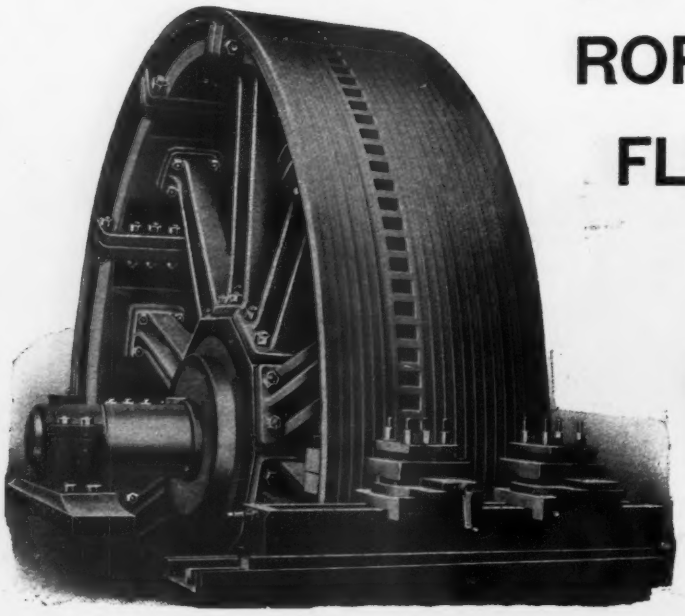

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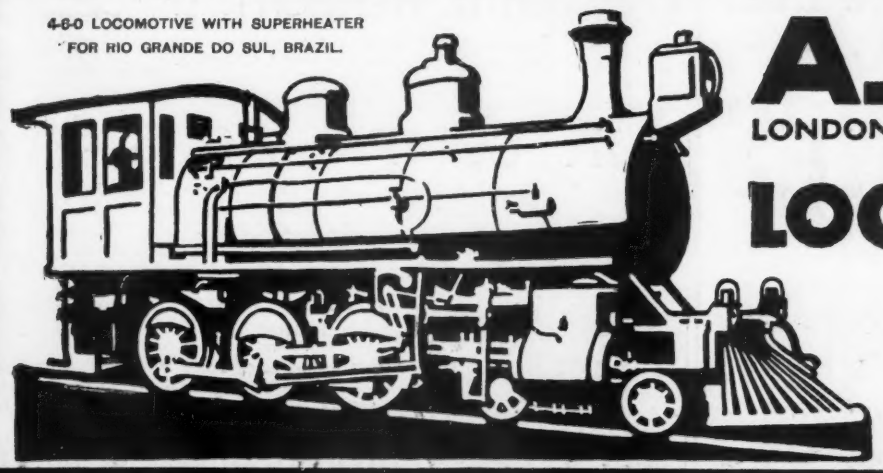

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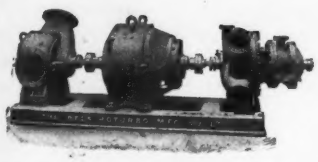

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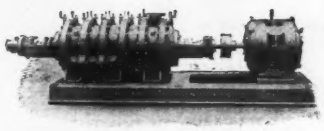

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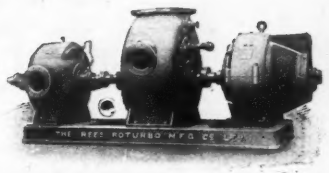

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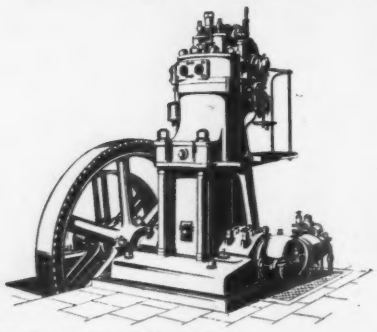

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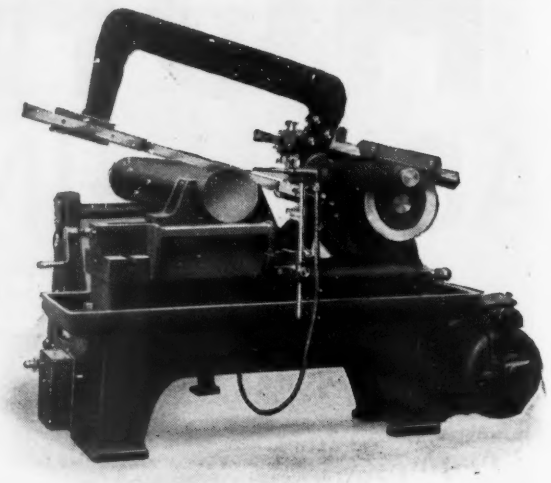

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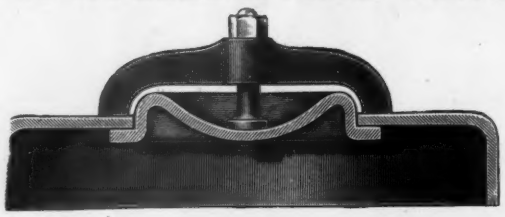

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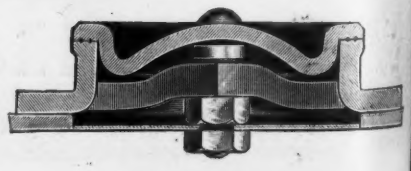

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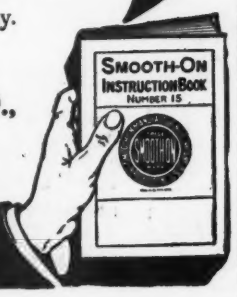


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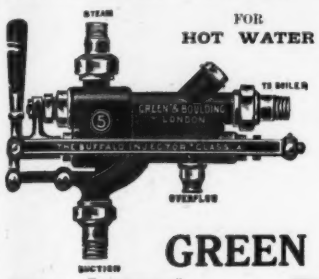


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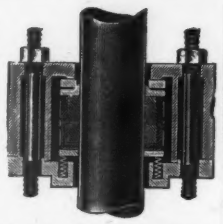

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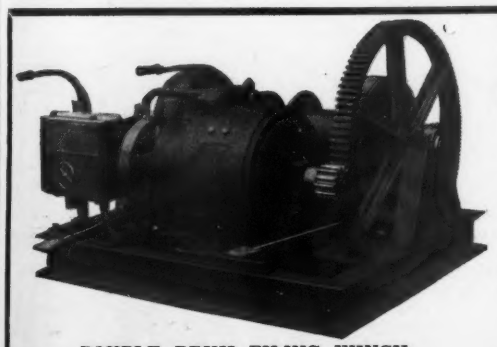

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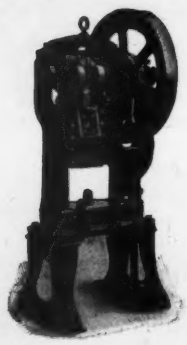

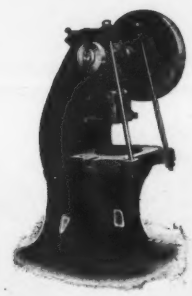

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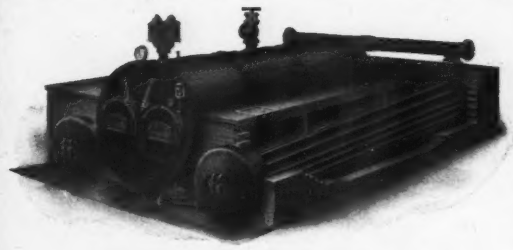

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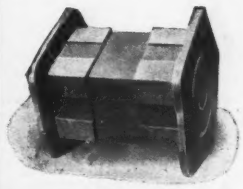

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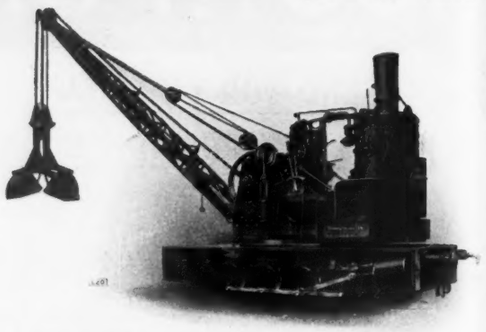

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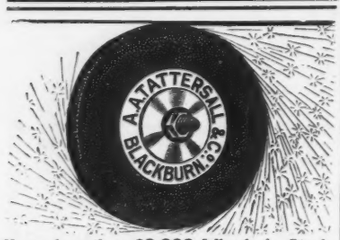


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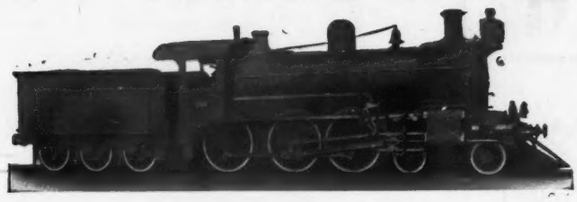

The illustration shows one of ten passenger locomotives, recently built for the Chilean State Railways. The track gauge is 5 feet 6 inches; the cylinders are 20 x 26 inches, and the driving wheels are 66 inches in diameter. Four of these locomotives are fitted with Schmidt Superheater.

These engines have plate frames and copper fireboxes, and were built throughout to drawings and specifications furnished by the Railway Company.

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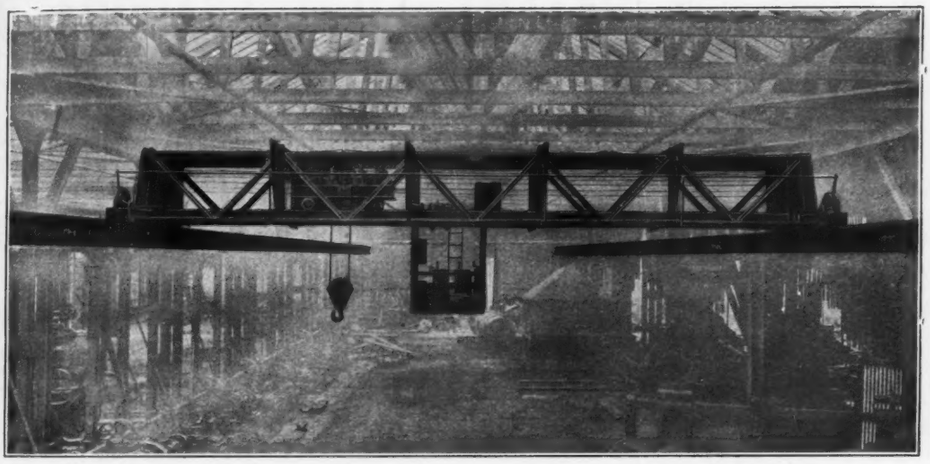

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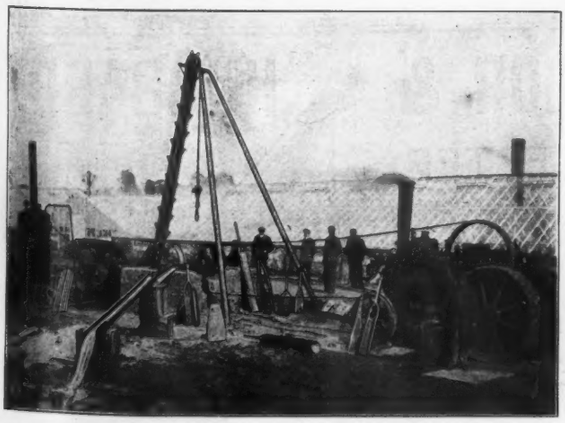

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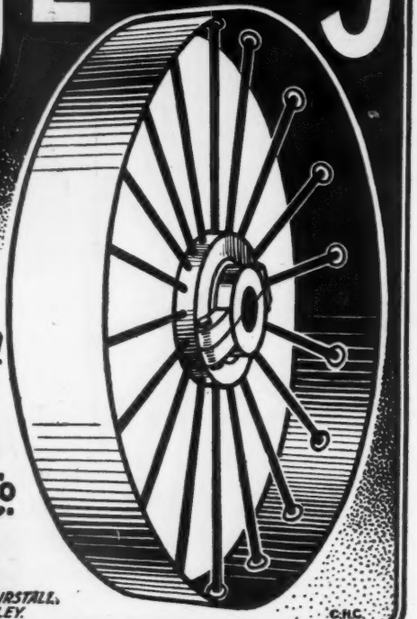

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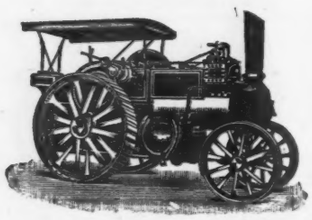

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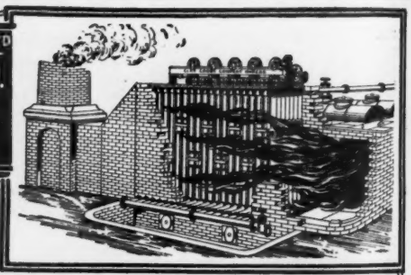

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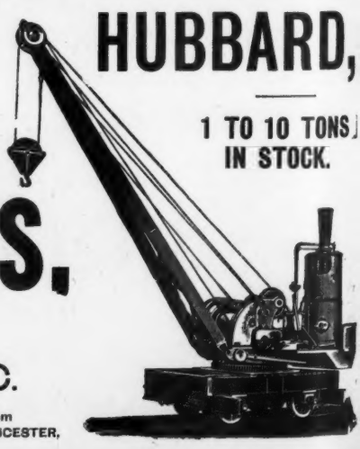

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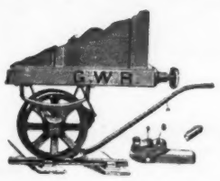


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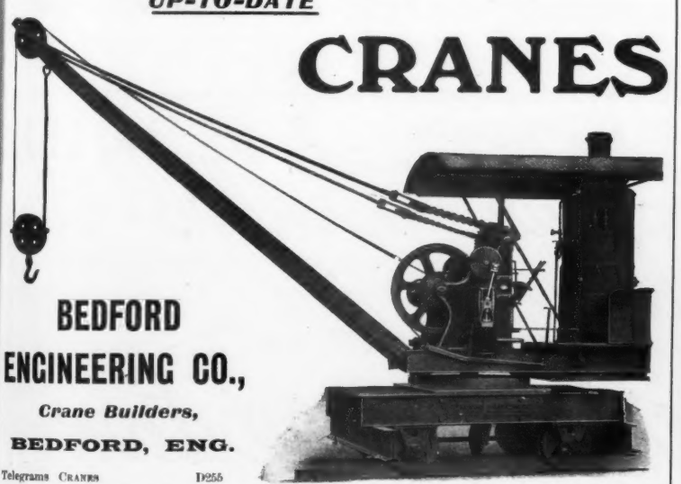

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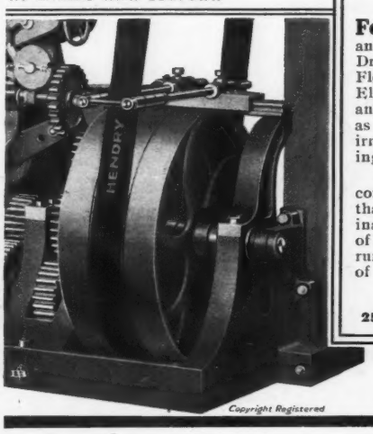


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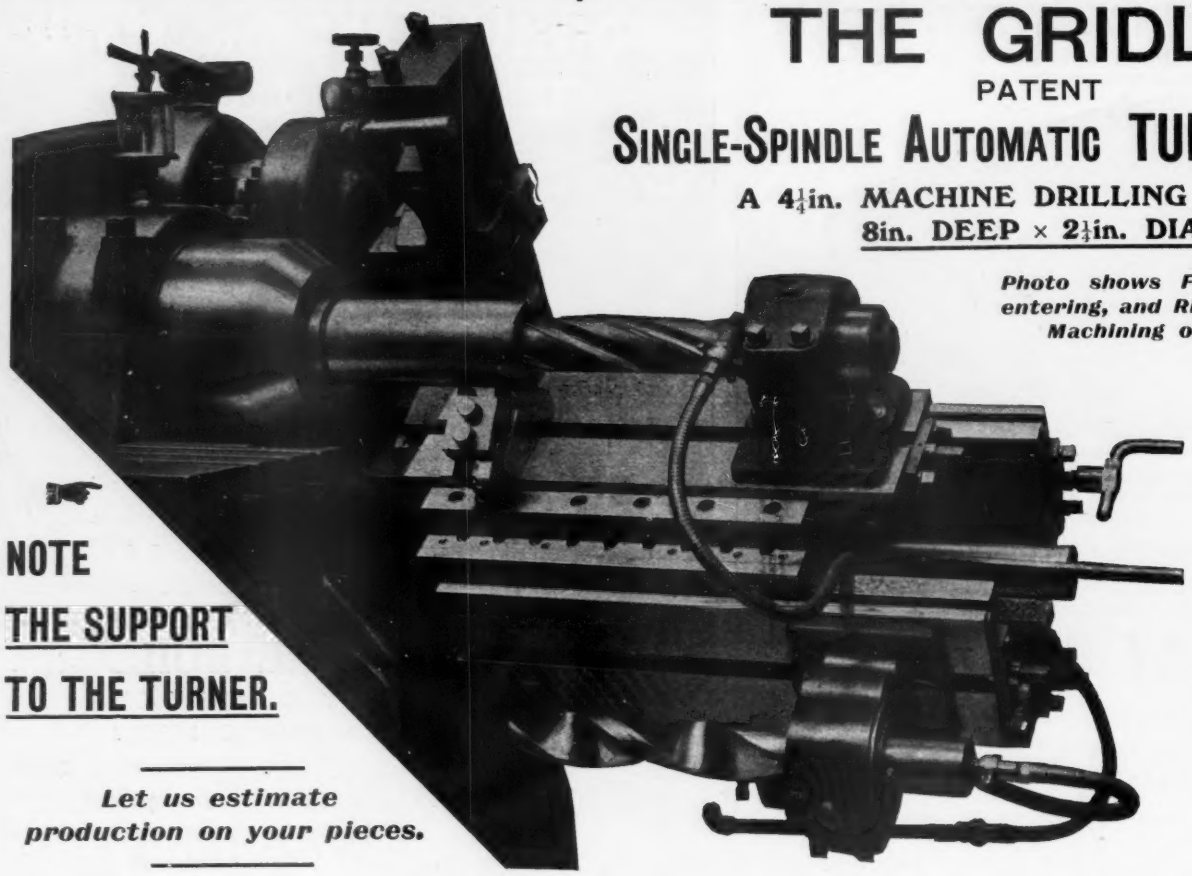

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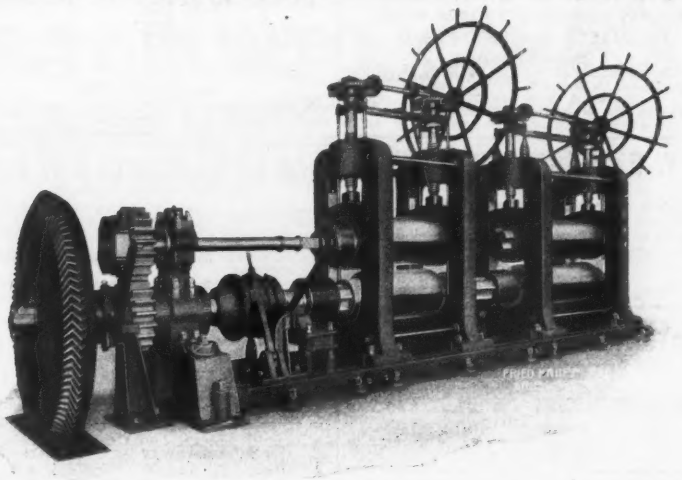

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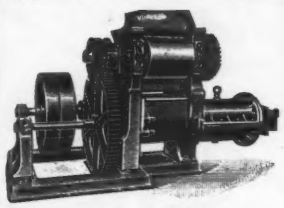

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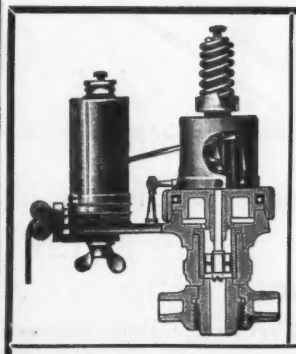

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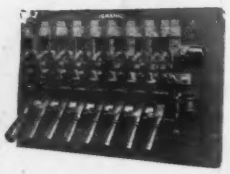

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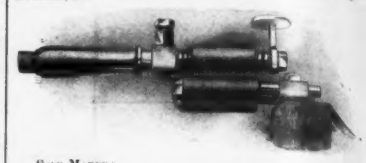
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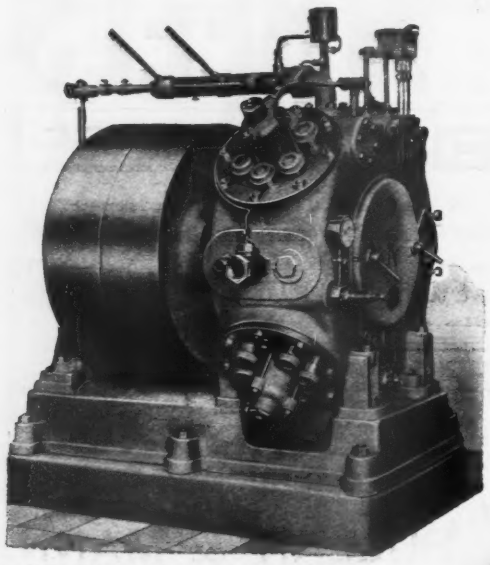
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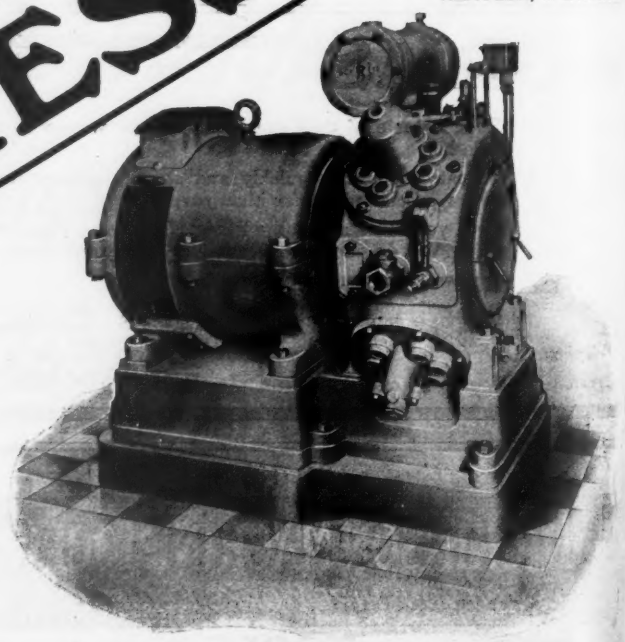
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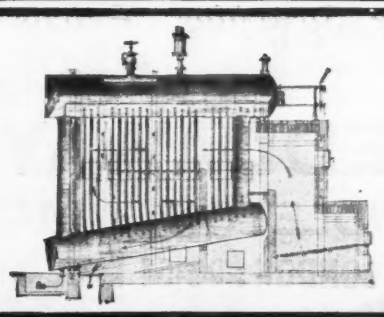

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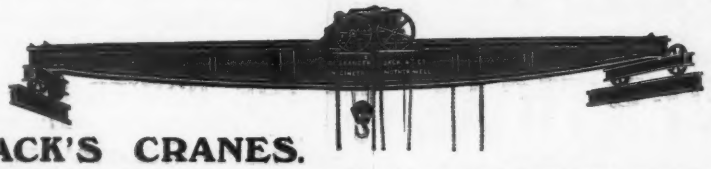

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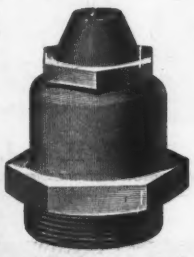

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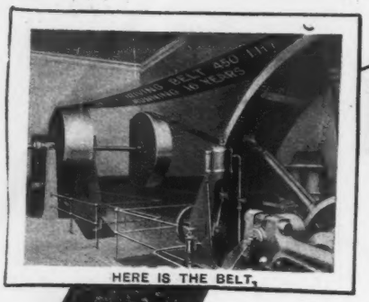


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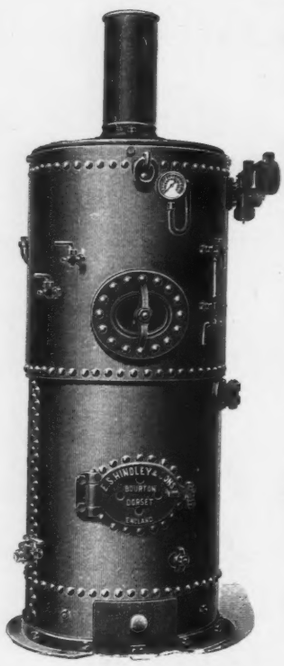

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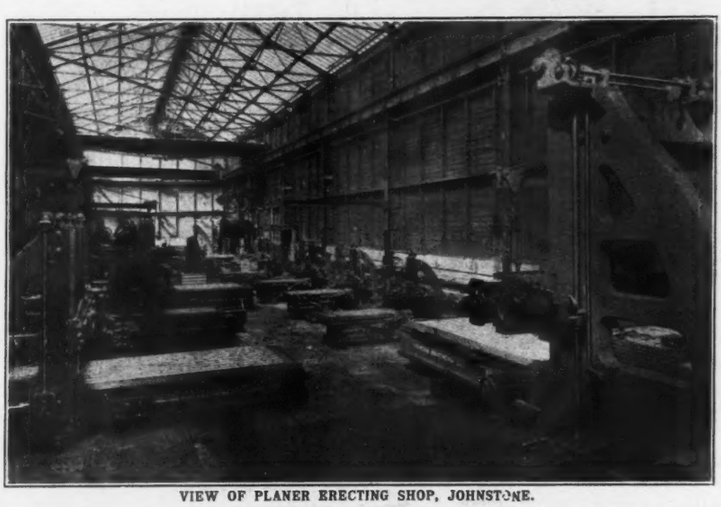

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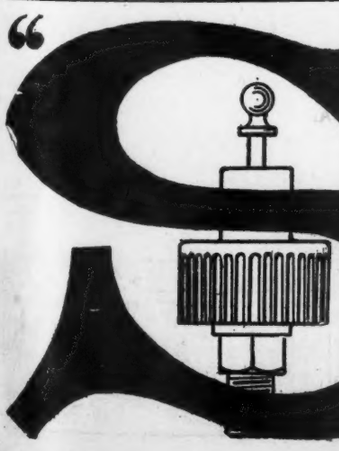

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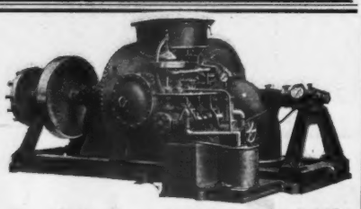

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Butters Bros. and Co
Chambers, Scott and Co
Chapman, A., and Co
Coles, H. J., Ld
Cowans, Sheldon and Co., Ld
Craven Brothers, Ld
Davy Bros., Ld
Derome Brothers
Duisburg Maschinenfabrik
Fielding and Platt, Ld
Gibbins, R. C., and Co
Grafton and Co
Grieve, J., and Co
Henderson, J. M., and Co
Isles, Ltd
Jack, A., and Co
Marshall, Fleming and Co
Mitchell-Williams Crane Co
Morgan, W., and Co
Morris, Herbert, Ld
Northern Engineering Works
Ransome and Rapier, Ld
Russell, G., and Co
Smith, John (Keighley), Ld
Smith, T., and Sons (Rodley)
Vaughan, A. F.
Stothert and Pitt, Ld
Taylor and Hubbard
Vaughan and Son, Ld
Wilson, J. H., and Co., Ld

**Cupolas**
Davies, T., and Son

**Destructors**
Manlove, Alliott and Co., Ld

**Diesel Oil Engines**
A.-B. Diesels Motorer
M.A.N. Co. (Maschinenfabrik Augsburg-Nurnberg A.G.)
Neville Bros
Sulzer Bros.
Swiderski, J.

**Distilling Plant**
Blair, Campbell & McLean, Ld

**Diving Apparatus**
Siebe, Gorman and Co., Ld

**Drawings and Tracings**
Thorp, J. B.

**Dredge Plant**
Bucyrus Co
Ferguson Brothers
Fleming and Ferguson, Ld
Gwynnes Limited
Lobnitz and Co., Ld
Priestman Bros., Ld
Simons, W., and Co., Ld
Smulders, A. F.
Werf Conrad, Ld

**Driving Ropes**
Kenyon, W., and Sons, Ld

**Drop Forgings and Stampings**
Armstrong, Stevens and Son
Carron Company
Smethwick Stamping Co

**Drop Hammers**
Brett's Patent Lifter Co. Ld

**Electricity**
Crompton and Co., Ld
Dick, Kerr and Co., Ld
Electromotors Limited
Ferranti Limited
Fowler, J. and Co., Ld
Hall, J. F., and Co
Hartnell, W., and Co., Ld
Phœnix Dynamo Co., Ld
Rees Roturbo Mfg. Co., Ld
Siemens Bros. Dynamo Works

**Electric Tools**
Wolf, S., and Co., Ld

**Electric Welding**
British Insulated and Helsby Cables, Ld

**Elevators**
Bagshawe and Co., Ld
Chain Belt Engineering Co
Conveyor and Elevator Co
East Ferry Road Eng'g Co
Leech, Goodall and Co

**Emery, Emery Wheels, &c.**
Carborundum Co., Ld
Davies, W. J., and Sons
Lake and Spencer, Ld
Oakey, J., and Sons
Sterne, L., and Co., Ld
Tattersall, A. A., and Co

**Engine and Boiler Fittings, &c.**
Bailey, Sir W. H., and Co., Ld
Bell's United Asbestos Co., Ld
Hopkinson, J., and Co., Ld
Hulburd Engineering Co
Klinger, R., and Co
Schaffer and Budenburg, Ld

**Engineers' Studs**
Beebee, A.

**Evaporators**
Blair, Campbell and McLean
Davie and Horne

**Excavators**
Austin Drainage Excavator Co
Bucyrus Co
Priestman Bros., Ld

**Explosives**
Curtis's and Harvey, Ld

**Fans and Turbines**
Armfield, J. J., and Co
Boving and Co., Ld
Brotherhood, Peter, Ld
Bumsted and Chandler, Ld
Davidson and Co., Ld
Gibbs, John, and Sons
Gilkes, G., and Co., Ld
Gunther, W., and Sons
Keith and Blackman Co., Ld
Parsons, C. A., and Co
Standard Engineering Co., Ld
Sturtevant Engineering Co
Turbon Patent Fan Co., Ld
Waddle Patent Fan and Engineering Co

**Feed-water Heaters**
Caird and Rayner
Davie and Horne
Royles Limited
Weir, G. and J., Ld
Wright's Forge & Eng. Co., Ld

**Feed-water Regulators**
Kater and Ankersmit

**Filters, Waste Oil**
Wells, A. C., and Co

**Fire Extinguishers**
Pyrene Co

**Flexible Metallic Tubing**
Interlock Metal Hose Co

**Forced Draught**
Davy Bros., Ld
Howden, J., and Co
Meldrums, Ld
Musgrave and Co., Ld

**Forgings**
Darlington Forge Co., Ld
Firth, T., and Sons, Ld
Grantham Boiler and Crank Co
Ince Forge Co., Ld
Mills, Exors. of J.
Rotherham Forge Co., Ld
Walker Bros., Ld., Wigan
Williams, J. H., and Co

**Foundry Equipment**
Phillips, J. W. and C. J., Ld

**Friction Clutches**
Bridge, D., and Co., Ld
British Hele-Shaw Clutch Co
Coil Clutch Co., Ld
Edmeston, A., and Sons, Ld
Harpers Limited
Kay, J. C., and Co., Ld
Unbreakable Pulley and Mill Gearing Co., Ld
Wigglesworth, F., and Co., Ld

**Fuel Economisers**
Clay Cross Co
Green, E., and Son
Lowcock, A., Ld

**Furnace Bars**
Miller and Co., Ld

**Furnaces**
British Rockwell Co
Brown, J., and Co., Ld
Burdon, J., and Sons
Dowson and Mason Gas Plant Co., Ld
Leeds Forge Co., Ld

**Fusible Plugs**
Bailey, Sir W. H. and Co., Ld
National Boiler and General Insurance Co

**Galvanised Sheets**
Ramshay and Marshall, Ld

**Galvanising Plant**
Butterfield, W. F., Ld
Lysaght, J., Ld

**Gas**
Dowson & Mason Gas Plant Co
Power Gas Corporation, Ld

**Gas Engines**
Bates, W. J., and Co., Ld
Crossley Brothers, Ld
Davey, Paxman and Co., Ld
Dudbridge Ironworks, Ld
Gardner, L., and Sons, Ld
Hindley, E. S., and Sons
Hornsby, R., and Sons, Ld
M.A.N. Co. (Maschinenfabrik Augsburg-Nurnberg A.G.)
Mather and Platt, Ld
National Gas Engine Co., Ld
Premier Gas Engine Co., Ld
Robson, J. (Shipley), Ld
Ruston, Proctor and Co., Ld
Thyssen and Co

**Gauge Glasses**
Bishop, S. and C., and Co
Butterworth Bros., Ld
Guilbert-Martin
Hopkinson, J., and Co., Ld
Mohron, Caspar
Tomey, J., and Sons, Ld

**Gauge Glass Protectors**
Holden and Brooke, Ld
Tomey and Sons, Ld

**Gauges**
Crosby Steam Gage & Valve Co
Klinger, R., and Co
Negretti and Zambra
Newall Engineering Co
Schaffer and Budenberg, Ld
Tomey and Sons, Ld

**Gear Cutting**
Barlow and Chidlaw, Ld
Brown, D., and Sons, Ld
Greenwood's Gear Cutting Co
Holtzapffel and Co
Woolnacott, H., and Co

**Gearing**
Bodley Brothers and Co
Brown, D., and Sons, Ld
Citroen Gear Co., Ld
Croft and Perkins, Ld
Harpers Limited
Northern Manufact'g Co., Ld
Power Plant Co., Ld
Reid Gear Co
Rodgers Bros
Wrigley, E. G., and Co., Ld

**Governors**
Campart, C. C.
Hollingdrake, H., and Son
Newton, Bean and Mitchell
Pitman, Percy
Pollock, Macnab and Highgate
Storey, I., and Sons, Ld

**Grinding Machinery**
Bradley Pulveriser Co
Churchill, C., and Co., Ld
Lake and Spencer, Ld
Smedley Bros., Ld

**Grindst'ne Dressers and Safety Rests**
Brunton and Trier

**Hammers**
Davis and Primrose
Massey, B. and S.
Player, W. and J.
Pollock, Macnab and Highgate

**Handles**
Burley and Son, Ld

**Harbour Plant**
Stothert and Pitt, Ld

**Haulage Gear**
East Ferry Road Eng'g Co
Grant, Ritchie and Co

**Heating Apparatus**
Browning, W. E., and Co., Ld
Ferranti Ld
Holden and Brooke, Ld
Körting Bros., Ld

**Hose**
India-rubber, Gutta-percha, & Telegraph Works Co., Ld
Merryweather and Sons, Ld
Reddaway, F., and Co., Ld

**Hydraulic Machinery**
Fielding and Platt, Ld
Holt and Willetts
Pratchitt Bros
Rice and Co
Shaw, [illegible] and Sons, Ld
Smith Bros. and Co., Ld
Smith, H., and Co
Stewart, Bryan and Co., Ld
Youngs

**Hydro-extractors**
Broadbent, T., and Sons, Ld

**Ice Machinery** (*see* Refrigerating Mach'y)

**Igniter, Gas and Oil Engine**
Lodge Bros. and Co

**India-rubber, &c.**
Dunlop Rubber Co., Ld
Reddaway, F., and Co., Ld

**Injectors and Ejectors**
Davies and Metcalfe, Ld
Green and Boulding, Ld
Gresham and Craven, Ld
Klinger, R., and Co.

**Iron and Steel Works Plant**
Jones, George, Ld
Perry, T., and Son, Ld
Stevensons, Preston

**Iron and Steel Buildings & Roofs**
Anderson, D., and Son. Ld
Arrol, Sir W., and Co., Ld
Bain, W., and Co., Ld
Bennis, R., and Co., Ld
Boulton and Paul, Ld
Braby, F., and Co
Brownlie and Murray, Ld
Cammell Laird and Co., Ld
Clayton, Son and Co., Ld
Cleveland Bridge & Eng'g Co
Clyde Structural Iron Co.
Findlay, Alex., and Co., Ld
Grover and Co., Ld
Heenan and Froude, Ld
Lysaght, J., Ld
Main, A. and J., and Co
Mechan and Sons, Ld
Piggott, T., and Co
Walker Bros
Wright, Anderson and Co., Ld

**Jointing**
Graphite Products, Ld
Hudson, J., and Co., Succes's
India-rubber, Gutta-percha, & Telegraph Works Co., Ld
Jenkins Bros., Ld
Klinger, R., and Co
Smooth-On Mfg. Co
Walker, J., and Co

**Laundry Machinery**
Tullis, D. and J., Ld

**Lead Machinery**
Glover, W. T., and Co., Ld
Krupp Grusonwerk, F.

**Lifts and Hoists**
Holt and Willetts
Northern Engineering Works
Stannah, J.
Waygood, R., and Co., Ld
Youngs

**Light**
Acetylene Illuminating Co
British Thomson-Houston Co
Carbic Limited
Continental-Light, Frankfort
Ullmann and Co., Ld
Wakefield, C. C., and Co
Wells, A. C., and Co

**Locks**
Kaye, J., and Sons, Ld

**Locomotives**
Avonside Engine Co., Ld
Bagnall, W. G., Ld
Baldwin Locomotive Works
Beyer, Peacock and Co., Ld
Borsig, A.
British Humboldt Eng'g Co
Fielding and Platt, Ld
Hawthorn, Leslie and Co., Ld
Hudswell, Clarke and Co
Hunslet Engine Co., Ld
Kerr, Stuart and Co., Ld
Manning, Wardle and Co., Ld
McEwan, Pratt and Co
Namurth, Wilson and Co., Ld
North British Loco. Co., Ld
Peckett and Sons
Société Anonyme ds Saint Léonard
Società Italiana Ernesto Breda
Stephenson, R., and Co., Ld
Vulcan Foundry Ld
Wolf, R

**Lubricators**
Bosch Magneto Co., Ld
British Mansel Oil Pump Co
Lubricators, Ld
Steam Cylinder Lubricator Co
Trier Bros.
Wakefield C. C. and Co

**Machine Tools**
Archdale, J., and Co., Ld
Asquith, W., Ld
Barker, Spink and Leese
Berry, F., and Sons, Ld
Buck and Hickman, Ld
Buckton, J., and Co., Ld
Burton, Griffiths and Co
Butler, J. and Co
Cameron, J., Ld
Chambers, Scott and Co
Churchill, C., and Co., Ld
Clifton and Baird, Ld
Clifton and Waddell
Craig and Donald, Ld
Craven Bros., Ld
Cunliffe and Croom, Ld
Davis and Primrose
Dean, Smith and Grace, Ld
Dempster, Moore and Co., Ld
Dickinson Machine Tool Co
Drummond Bros. Ld
German Niles Tool Works
Greenwood and Batley, Ld
Harvey, G., and Co
Heap, J., and Co., Ld
Herbert, A., Ld
Hetherington, J., & Sons, Ld
Hill, Isaac, and Son
Hulse and Co., Ld
Jones and Lamson Machine Co
Jones and Shipman, Ld
Kearns, H. W., and Co., Ld
Lang, J., and Sons
Lodge & Shipley M'c. Tool Co
London Bros., Ld
McGown, Rogers and Co
M'Kendrick, W. D., and Co
Muir, W., and Co
Noble and Lund, Ld
Parkinson, J., and Son
Pearn, F., and Co., Ld
Pfeil and Co
Platt, S., Ld
Pratt, F., and Co., Ld
Redman, C., and Sons
Reinecker, J. E.
Rice and Co., Ld
Richards, G., and Co
Schuchardt and Schutte
Scott Bros
Selson Engineering Co., Ld
Shanks, T., and Co
Smith and Coventy, Ld
Smith Bros. and Co., Ld
Smith, G. F., Ld
Smith, Hugh, and Co., Ld
Spencer, James
Stirk, J., and Sons, Ld
Tangyes Limited
Tuills, D. and J., Ld
U.S. Metallic Packing Co., Ld
Vickers Limited
Ward, H. W., and Co
Ward, T. W., Ld
Webster and Bennett, Ld
Westinghouse Brake Co., Ld
Wilson, A.

**Machine Work**
Hooker, Peter, Ld
Rosser and Russell, Ld
Walles, G., and Co

**Malleable Castings**
Ley's Malleable Castings Co

**Manganese Steel Castings & Forg'gs**
Cammell Laird and Co., Ld
Firth, T., and Sons, Ld
Hadfield's Steel Foundry Co

**Manholes**
M'Neil, C.
Rolled Steel Forge Co., Ld

**Marine Motors**
Parsons Motor Co., Ld

**Mathematical Instruments**
London Name Plate Mfg. Co
Stanley, W. F., and Co., Ld

**Measur'g Machines**
Newall Engineering Co

**Merchant Iron**
Dunkerley, C. C., and Co., Ld
Farnley Iron Co., Ld
Henderson and Glass

**Metals**
Atlas Metal & Alloys Co., Ld
Bull's Metal & Melloid Co., Ld
Clifford, C., and Son, Ld
Delta Metal Co., Ld
Electric and Ordnance Accessories Co., Ld
Glacier Anti-Fric't'n Metal Co
Johnson, Clapham and Morris
Magnolia Anti-Friction Metal Co. of Great Britain, Ld
Tandem Smelting Co., Ld

**Meters**
Glenfield and Kennedy, Ld
Siemens Bros. and Co., Ld

**Mica**
Wiggins, F., and Sons

**Mining Machinery**
Bennis, R., and Co., Ld
Davey, Paxman and Co., Ld
Hardy Patent Pick Co., Ld
Head, Wrightson and Co., Ld
Krupp Grusonwerk, F.
Ransomes, Sims and Jefferies
Robey and Co., Ld
Sandycroft, Ld
Sturtevant Engineering Co
Walker Brothers, Wigan

**Motors**
Bergius Launch & Engine Co
Electromotors Ld
Phœnix Dynamo Mfg. Co., Ld

**Motor Cars**
Clement Talbot Ld
Drewry Car Co., Ld
Mann's Patent Wagon Co
Thornycroft, J. I., and Co., Ld

**Moulding Machines**
Greenwood and Batley, Ld
Samuelson and Co., Ld

**Oil Cabinets**
Valor Co., Ld

**Oil Engines**
Aster Engineering Co., Ld
Bates, W. J., and Co., Ld
Blackstone and Co., Ld
Crossley Brothers, Ld
Dudbridge Ironworks, Ld
Gardner, L., and Sons
Hornsby and Sons, Ld
Kind, Ing. P., and Co
Mirrlees, Bickerton & Day, Ld
Normand, A., Ld
Petters Ld
Plenty and Son, Ld
Reavell and Co, Ld
Tangyes Limited
Westinghouse Brake Co., Ld
Wilson, A.
Wilson, C. F., and Co

**Oil Separators**
Baker Oil Separator Co., Ld
Balcke and Co., Ld
Garner, Telford and Hardman
Paterson Engineering Co., Ld

**Oil Mill Machinery**
Rose, Downs & Thompson, Ld

**Oil Pumps**
British Manzel Oil Pump Co

**Oils and Lubricants**
American Commerce Co., Ld
Kanis, A. W.
Price's Company Limited
Trier Brothers
Wakefield, C. C., and Co
Wells, Henry, Oil Co
Willcox, W. H., and Co., Ld

**Overhead Runways**
Morris, Herbert, Ld
Vaughan and Son, Ld

**Oxygen**
British Oxygen Co., Ld

**Packing, Metallic**
Green and Boulding, Ld
Greene, Tweed and Co
Hobdell, Way and Co., Ld
Hudson, J., & Co., Successors
Klinger, R., and Co
Lancaster and Tonge, Ld
U.S. Metallic Packing Co., Ld
Walker, J., and Co
Willcox, W. H., and Co., Ld

**Paint**
Rudman, James

**Painting Machines**
Wells, A. C., and Co

**Patent Agents**
Alexander, E. P., and Son
Cruikshank & Fairweather, Ld
Harris and Mills
Jensen and Son
Skerrett, Henry
Vaughan and Son
Withers, J. S., and Spooner

**Pattern Shop Equipment**
Phillips, J. W. and C. J., Ld

**Perforated Metals**
Barns, W., and Son

**Photo Printing**
Halden, J., and Co., Ld
Hall, B. J., and Co., Ld
Union Electric Co., Ld

**Pig Iron**
Clay Cross Co
Lilleshall Co

**Pile Drivers**
British Steel Piling Co

**Pipes, Iron & Steel**
Ashmore, Benson, Pease & Co
Boving and Co., Ld
Clayton, Son and Co., Ld
Mechan and Sons, Ld
Piggott, T., and Co., Ld
Stewarts and Lloyds, Ld

**Pintons**
Lancaster and Tonge, Ld
Lockwood and Carlisle, Ld
M'Neil, C., jun.
Oldham, A., and Sons
Standard Plain Ring Co., Ld

**Plates, Steel**
Colville, D., and Sons, Ld
Glasgow Iron and Steel Co
Stewarts and Lloyds, Ld
Veithardt and Hall, Ld

**Plummer Blocks**
Jardine, J.
Unbreakable Pulley Co., Ld
Wigglesworth, F., and Co., Ld

**Pneumatic Tools**
Consolidated Pneumatic Tool Co., Ld
Globe Pneumatic Eng. Co., Ld
Howard Pneumatic Eng. Co

**Presses**
Arrol, Sir W., and Co., Ld
Brett's Patent Lifter Co., Ld
Fawcett, Preston and Co., Ld
Hands, J., and Sons, Ld
Hordern and Mason
Taylor and Challen, Ld

**Printing**
Reveirs, Geo., Ld

**Pulley Blocks**
Derome Brothers
Morris, Herbert, Ld
Vaughan and Son, Ld

**Pulleys**
Douglas, Lawson and Co
Harpers Limited
Hudswell, Clarke and Co., Ld
Mackies, Ld
Smith and Grace
Thompson and Southwick, Ld
Unbreakable Pulley Co., Ld
Urquhart, Lindsay & Co., Ld

**Pump Buckets**
N.P. Pump Bucket Co

**Pumps**
American Well Works
Arrol, Sir W., and Co., Ld
Bailey, Sir W. H., and Co., Ld
Batchelor, Richd. D.
Brackett, F. W., and Co., Ld
Carruthers, J. H., and Co
Daniels, T. H. and J., Ld
Deming Co
Drum Engineering Co
Drysdale, J., and Co
Easton and Anderson
Evans, J., and Sons
Fleming and Ferguson, Ld
Friedenthal, F.
Gilkes, G., and Co., Ld
Glenfield and Kennedy, Ld
Gwynnes Ld
Hall, J. P., & Sons, Peterboro
Hathorn, Davey and Co., Ld
Haywards, Ltd
Hughes and Lancaster
Leeds Eng. and Hydraulic Co
Lilleshall Co
Merryweather and Sons, Ld
Mumford, A. G., Ld
Musgrave Bros
Pearn, F., and Co., Ld
Pulsometer Engin'ng Co., Ld
Reader, E., and Sons
Rees Roturbo Mfg. Co., Ld
Richards, R., and Sons, Ld
Simpson, J., and Co., Ld
Sulzer Bros
Warner, R., and Co., Ld
Weir, G. and J., Ld
Worthington Pump Co., Ld

**Railway Plant**
Bagnall, W. G., Ld
Birch, J., and Co., Ld
Bolling and Lowe
Cravens, Limited
Dick, Kerr and Co., Ld
Firth, T., and Sons, Ld
Fowler, J., and Co.
Glasgow Rly. and Engin'g Co
Grimth, W., and Sons
Harrison and Camm, Ld
Hudson, R., Ld
Hurst, Nelson and Co., Ld
Isca Foundry Co., Ld
Kerr, Stuart and Co., Ld
Leeds Forge Co., Ld
Maclellan, P. and W., Ld
McLachlan and Co.
Midland Railway Carriage Co
Motor Rail & Tramcar Co., Ld
Patent Shaft and Axletree Co
Pickering, R. Y., and Co., Ld
Ransomes and Rapier, Ld
Renton, R. M., and Co
Stableford and Co
Summerson, T., and Sons, Ld
Turner, G. R., Ld
United Electric Car Co., Ld

**Railway Signalling**
McKenzie and Holland, Ld

**Rams, Hydraulic**
Bailey, Sir W. H., and Co., Ld
Blake, John, Ld

**Recording Instruments**
Bristol Company

**Reducing Valves**
Auld, D., and Son
British Steam Specialties
Royles Limited

**Refrigerating Machinery**
Hall, J. and E., Ld
Haslam Foundry and Engineering Co., Ld
Linde British Refrigeration Co
Liverpool Refrigeration Co
Pulsometer Engineering Co
Sterne, L., and Co., Ld
Worsaam, G. J., and Son, Ld

**Reinforc'd Concrete**
Stewart, J. and W.

**Rivets**
Lyall Brothers

**Rolls and Rolling Mill Plant**
Love's Non-deflection Patents Syndicate
Tennent, R. B., Ld

**Roofs** (*see* Iron Bldgs.)

**Rubber Machinery**
Entwisle and Gass, Ld

**Sand Blast Machinery**
Hooker, Peter, Ld
Tilghman's Sand Blast Co., Ld

**Saws**
Herbert, Edward G., Ld

**Screens**
Parker, Winder and Achurch

**Screwing Tackle**
Chatwin, T., Ld
Heap, J., and Co., Ld
Hulse and Co., Ld
Widdowson, J. H.

**Sea Water Distillers**
Fawcett, Preston and Co., Ld

**Separators**
Rapid Magnetting Mach. Co

**Sewage Plant**
Manlove, Alliot and Co., Ld

**Shafting**
Bagshaw, J., and Sons, Ld
Dunford and Elliott, Ld
Fraser, Douglas, and Sons, Ld
Govan Snafting Co
Harpers Limited
Jardine, J.
Platt, S., Ld

**Shearing Machines**
Jones, Geo., Ld
Perry, T., and Son, Ld

**Ship Construction**
Isherwood, J. W.

**Shutters, Steel Rolling**
Gibson, A. L., and Co

**Signalling, Power**
McKenzie, Holland & Westinghouse Power Signal Co

**Small Tools**
Chatwin, T.
Gilman, Frank
Greville (Liverpool) Ld
Vickers Limited

**Springs**
Burstinghams and Co., Ld
Salter, G., and Co

**Steam Engines**
Belliss and Morcom, Ld
Burrell, C., and Sons
Clarke, Chapman and Co., Ld
Clayton and Shuttleworth, Ld
Cole, Marchent and Morley, Ld
Davey, Paxman and Co., Ld
Drysdale and Co., Ld
Easton and Johnson, Ld
Garrett, R., and Sons, Ld
Hindley, E. S., and Sons
Howden, J., and Co
Lanz, Heinrich
Lees, T. and R.
Lilleshall Co., Ld
Plenty and Son, Ld
Reader, E., and Sons
Reavell and Co., Ld
Richardsons, Westgarth & Co
Robey and Co., Ld
Ruston, Proctor and Co., Ld
Samuelson and Co., Ld
Saxon, George, Ld
Sisson, W., and Co., Ld
Stott, S. S., and Co
Tangyes Limited
Wilson, A.
Yates and Thom, Ld

**Steam Launches**
Cochran and Co., Annan, Ld
Fleming and Ferguson, Ld
Joy, D., and Collis, Ld
Lobnitz and Co., Ld
Simons, W., and Co., Ld
Yarrow and Co., Ld

**Steam Meters**
British Thomson-Houston Co
Curnon Steam Meter Co

**Steam Separators**
Lancaster and Tonge, Ld

**Steam Traps**
Bailey, Sir W. H., and Co., Ld
Geipel, Wm., and Co
Hobdell, Way and Co., Ld
Lancaster and Tonge, Ld
Royles Limited
United Brassfounders and Engineers, Ld

**Steel**
Beardmore, W., and Co
Beckett, A., and Sons, Ld
Brown, Bayley's Steel Works
Brown, J., and Co., Ld
Colville, D., and Sons, Ld
Fairley, James, and Sons
Firth, T., and Sons, Ld
Flockton, Tompkin & Co., Ld
Glasgow Iron and Steel Co., Ld
Hadfield's Steel Foundry Co
Howell and Co., Ld
Jessop, W., and Sons, Ld
Rogerson, J., and Co
Sankey, J., and Sons, Ld
Spencer, J., and Sons
Steel Company of Scotland
Stewarts and Lloyds, Ld
Turton, T., and Son
Vickers Limited

**Steel Balls**
Auto Machinery Co., Ld

**Steel Sheets**
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